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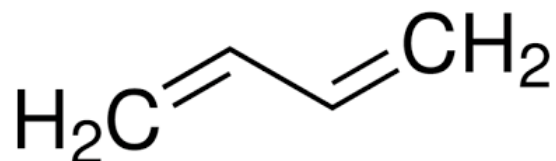
December 2025

Office of Chemical Safety and
Pollution Prevention

General Population Exposure for 1,3-Butadiene

Technical Support Document for the Risk Evaluation

CASRN 106-99-0



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KEY ABBREVIATIONS AND ACRONYMS

AAMG	Ambient Air Monitoring Group
ADAF	Age-dependent adjustment factor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AMTIC	Ambient Monitoring Technology Information Center
CAA	Clean Air Act
CASRN	Chemical Abstracts Service Registry Number
CMAQ	Community Multiscale Air Quality
COU	Conditions of use
EPA	Environmental Protection Agency (U.S.)
HAP	Hazardous Air Pollutant
HEC	Human Equivalent Concentration
HEM	Human Exposure Model
HON	Hazardous Organic NESHAP
IIOAC	Integrated Indoor Outdoor Air Calculator
IUR	Inhalation unit risk
LADC	Lifetime average daily concentration
MDL	Method limit of detection

MOE	Margin of exposure
NAICS	North American Industry Classification System
ND	Non-detect
NEI	National Emissions Inventory
NESHAP	National Emission Standards for HAPs
OAR	Office of Air and Radiation (EPA)
OCSP	Office of Chemical Safety and Pollution Prevention (EPA)
OES	Occupational exposure scenario
OPPT	Office of Pollution Prevention and Toxics (EPA)
POD	Point of departure
RfC	Reference concentration
RSEI	Risk-Screening Environmental Indicators
RTR	Risk and Technology Reviews
SAB	Science Advisory Board
SACC	Science Advisory Committee on Chemicals
SOCMI	Synthetic Organic Chemical Manufacturing Industry
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TSD	Technical support document
U.S.	United States

SUMMARY

This technical support document (TSD) accompanies the Toxic Substances Control Act (TSCA) *Risk Evaluation for 1,3-Butadiene* ([U.S. EPA, 2025h](#)) (see Appendix C of the risk evaluation for a complete list of all TSDs and supplemental files). This TSD presents the quantitative assessment of general population exposures to 1,3-butadiene via the ambient air pathway. The exposure assessment aids in the development of the general population risk estimates presented in Section 5.3.4 of the risk evaluation.

Key Points: General Population Exposure Assessment

The following bullets summarize the key points of this general population exposure assessment:

- 1,3-Butadiene is ubiquitous in the ambient air; therefore, EPA (or the Agency) quantitatively assessed human exposure to 1,3-butadiene via the ambient air pathway.
- EPA presents both measured and modeled concentrations of 1,3-butadiene from multiple lines of evidence, data, and analyses in this ambient air exposure assessment to evaluate and contextualize 1,3-butadiene exposures for multiple conditions of use (COUs) under TSCA.
- EPA used a three-tiered (I–III) approach for assessing general population exposures and risks.
- For Tier I, EPA used the Integrated Indoor/Outdoor Air Calculator (IIOAC) to model industrial releases reported to the Toxics Release Inventory (TRI) for the years 2016 through 2021 (Section 2.2.3.1)
 - Tier I-modeled concentrations and risk estimates with IIOAC and TRI facility releases resulted in cancer risk estimates that warranted refined analyses.
- For Tier II, EPA used the Human Exposure Model (HEM) to assess industrial releases reported to TRI for the years 2016 through 2021 (Section 2.2.3.2)
 - Tier II-modeled concentrations and risk estimates with HEM and TRI facilities releases resulted in cancer risk estimates that warranted refined analyses.
- For Tier III, EPA used HEM to model industrial releases reported to the National Emissions Inventory (NEI) for the years 2017 and 2020.
 - Tier III analyses are presented in Section 5.3.4 of the *Risk Evaluation for 1,3-Butadiene*
- Seven years (2016–2022) of monitored 1,3-butadiene concentrations extracted from the Ambient Monitoring Technology Center (AMTIC) archive ranged from 0.0 to 267.3 $\mu\text{g}/\text{m}^3$ across all monitored 24-hour sampling values; and from 0.0 to 3,045.3 $\mu\text{g}/\text{m}^3$ across all monitored 1-hour sampling values.
- Monitored concentrations from the AMTIC archive above detection limits for 1,3-butadiene tended to be higher than modeled concentrations, though mean (average) and median concentrations were similar or within the same order of magnitude.
- The Agency used the 2020 AirToxScreen data developed by EPA’s Office of Air and Radiation (OAR) to further contextualize 1,3-butadiene concentrations in the ambient air from 38 different source categories, including fuel use and combustion-related emissions (Section 2.3.3.2).
- EPA has robust confidence in the characterization of exposures to 1,3-butadiene via the ambient air pathway/inhalation route because the Agency considered multiple lines of evidence that generally aligned in relation to monitored concentrations in the ambient air.

1 INTRODUCTION

1,3-Butadiene is a colorless gas that is produced during petroleum processing and is primarily used for synthetic rubber production, with small amounts found in plastics and fuel. It is released into the environment by industrial operations involved with manufacturing, processing, formulation, disposal, and other practices ([U.S. EPA, 2025c](#)). 1,3-Butadiene is also released into the ambient air through motor vehicle emissions, combustion, and other activities related to fuel use and products.

This assessment describes the use of reasonably available information to evaluate exposure of the general population to 1,3-butadiene. EPA evaluated releases of 1,3-butadiene from facilities that use, manufacture, or process the gas under industrial and/or commercial COUs subject to TSCA regulations, as detailed in the *Environmental Releases and Occupational Exposure Assessment for 1,3-Butadiene* ([U.S. EPA, 2025c](#)). In the *Environmental Media Concentrations for 1,3-Butadiene* ([U.S. EPA, 2025b](#)), EPA evaluated the presence of 1,3-butadiene in different media pathways (air, water, and land) through reported concentrations in peer-reviewed literature, gray literature,¹ and monitoring databases. Based on 1,3-butadiene's physical-chemical properties and fate parameters detailed in the *Physical Chemistry and Fate Assessment for 1,3-Butadiene* ([U.S. EPA, 2025g](#)), and further supported by data described in the *Environmental Media Concentrations for 1,3-Butadiene* ([U.S. EPA, 2025b](#)), exposures to 1,3-butadiene for the general population are only expected through the air pathway. Therefore, EPA conducted a quantitative assessment of general population exposures to 1,3-butadiene via the ambient air pathway and did not further evaluate the water or land pathways.

As detailed in the *Environmental Releases and Occupational Exposure Assessment for 1,3-Butadiene* TSD ([U.S. EPA, 2025c](#)), releases are reported to occur to the ambient air. Although subject to direct and indirect photolysis in the ambient air, 1,3-butadiene is ubiquitous—especially in the urban setting due to industrial releases and combustion related activities—and has consistently been found to be present in air based on testing and ambient monitoring implemented under multiple EPA programs. The Agency analyzed data from the TRI to evaluate facility air releases of 1,3-butadiene for the 2016 to 2021 reporting years. EPA also analyzed data from the National Emissions Inventory (NEI) for reporting years 2017 and 2020. A summary of NEI release data is presented in the *Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* ([U.S. EPA, 2025c](#)).

This TSD evaluates how releases of 1,3-butadiene impact the general population through ambient air exposure. EPA applied a three-tiered approach to assessing exposure via the ambient air pathway. In the first tier (I) of analysis, the Agency used the IIOAC with TRI release data as inputs to model concentrations of 1,3-butadiene in ambient air (Section 2.2.3.1). In the second tier (II) of analysis, EPA used the HEM with TRI release data for refined results based on site-specific days of operation and localized regional meteorological data to assess exposures at both radial distances and census blocks (Section 2.2.3.2). In the third (III) and final tier of analysis, EPA used HEM with NEI release data, which includes emission-unit specific parameters for further refined modeling results.

To provide context for modeled ambient air concentrations based on TRI and NEI releases, IIOAC- and HEM-modeled concentrations were compared to the measured concentrations of 1,3-butadiene in ambient air available in AMTIC (Section 2.3.2). EPA found that monitored concentrations from the AMTIC archive above method detection limits (MDLs) tended to be higher than modeled

¹ Gray literature is defined as the broad category of data or information sources not found in the standard, peer-reviewed literature databases such as PubMed and Web of Science. It is produced by organizations outside of traditional academic publishing channels. Gray literature includes data/information sources such as white papers, conference proceedings, technical reports, reference books, dissertations, information on various stakeholder websites, and various databases.

concentrations, though mean (average) and median concentrations were similar, or within the same order of magnitude. However, EPA recognizes that this is not a direct comparison since modeled concentrations are based on facility releases and associated to COUs while monitoring data extracted from AMTIC represent both 24- and 1-hour measured concentrations collected at air monitoring stations that vary in distance from TRI facilities and reflect all possible contributing sources—including sources associated with COUs and other sources not within the scope of this assessment (*e.g.*, vehicular mobile sources, tobacco smoke, residential wood burning, fires).

To provide context for the contribution to ambient air concentrations from other sources, the Agency evaluated existing modeled data from the 2020 AirToxScreen Assessments, which is conducted by EPA's Office of Air and Radiation (OAR) and based on NEI 2020-reported releases (Section 2.3.3.2).

1.1 Scope of the Risk Evaluation

The TSCA risk evaluation of 1,3-butadiene comprises several human health, environmental, fate, transport, and exposure assessment components—as well as a risk evaluation document. A diagram showing the relationships between assessments is provided in Figure 1-1. This general population exposure assessment (highlighted in blue) is one of five TSDs that are outlined in green.

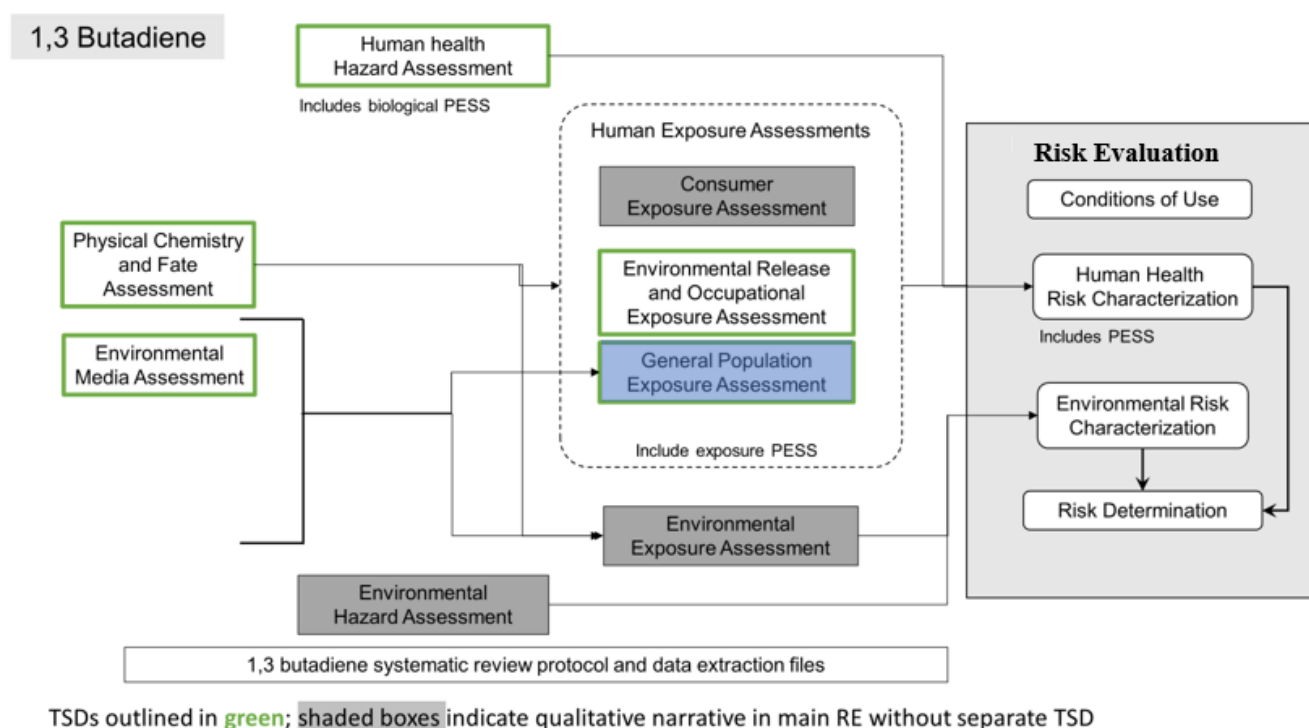


Figure 1-1. Risk Assessment Document Map Summary

1.2 Summary of the Chemistry, Fate, and Transport Assessment

1,3-Butadiene is primarily transformed in ambient air by indirect photolysis through reaction with ozone, nitrates, and hydroxyl radicals ($\cdot\text{OH}$) to form other chemicals. Studies indicate 1,3-butadiene has a half-life range of 0.76 to 9 hours, with the longer half-lives corresponding to periods without sunlight. Industrial releases and vehicular emissions are primary sources of 1,3-butadiene concentrations in ambient air. 1,3-Butadiene can also be formed as a product of combustion of organic matter such as petroleum products, wood, and coal. 1,3-Butadiene is volatile and will evaporate from water and soil and does not sorb to sediment. For these reasons, air is expected to be the major pathway of concern for

1,3-butadiene in the environment whereas water, sediment, and soil are expected to be minor compartments. Figure 1-2 below depicts the transportation and partitioning of 1,3-butadiene in the environment. For more details, see the *Physical Chemistry and Fate Assessment for 1,3-Butadiene* ([U.S. EPA, 2025g](#)).

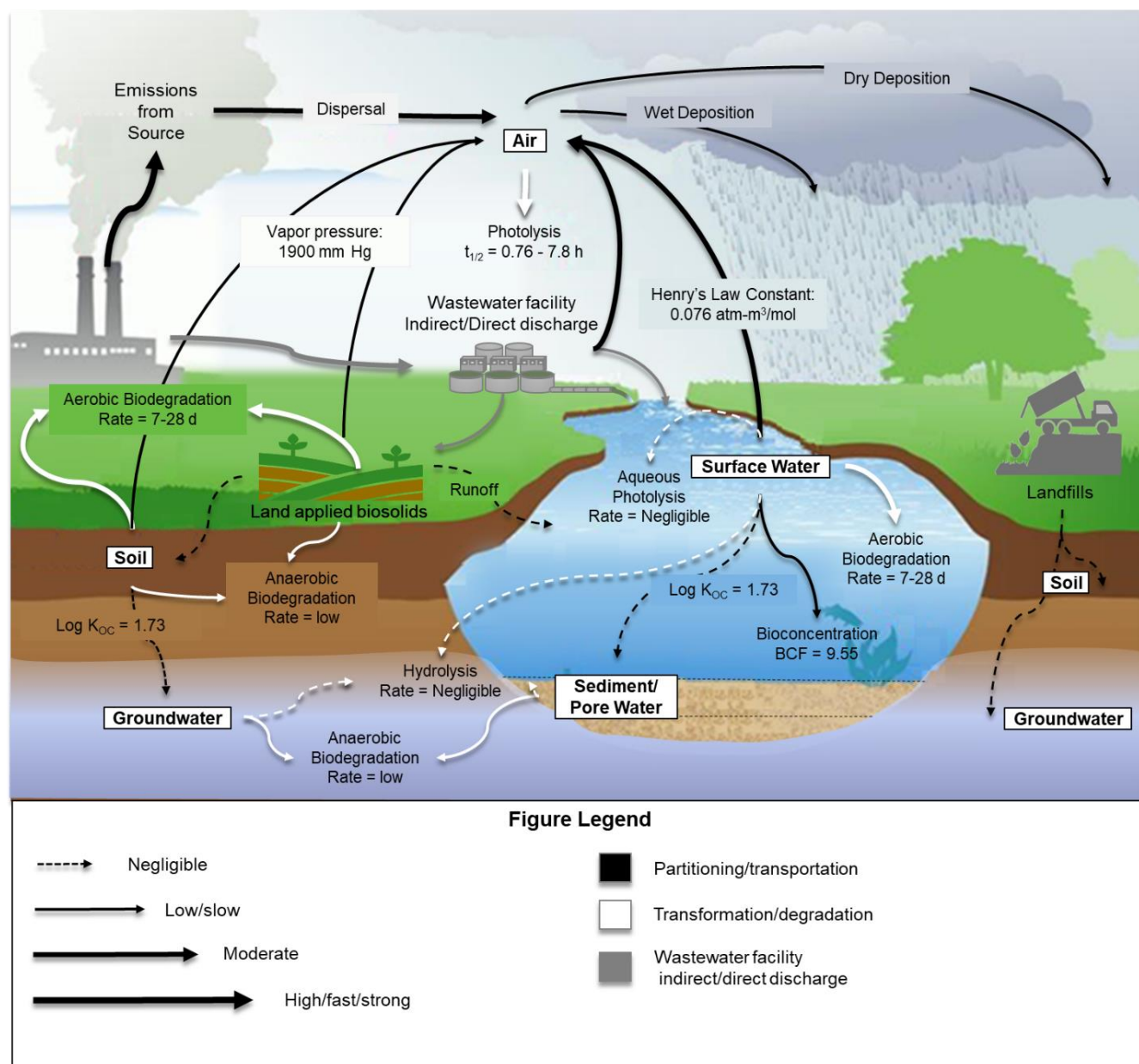


Figure 1-2. Transport, Partitioning and Degradation of 1,3-Butadiene in the Environment
The diagram depicts the distribution (grey arrows), transport and partitioning (black arrows) as well as the transformation and degradation (white arrows) of 1,3-butadiene in the environment. The width of the arrow is a qualitative indication of the likelihood that the indicated partitioning will occur or the rate at which the indicated degradation will occur (i.e., wider arrows indicate more likely partitioning or more rapid degradation).

2 APPROACH AND METHODOLOGY

As described in Section 1, 1,3-butadiene exposures to the general population are expected to occur only through the ambient air pathway. Therefore, EPA applied a three-tiered modeling approach to estimate general population exposures to 1,3-butadiene resulting from reported releases from industrial facilities. Monitoring data obtained from multiple ambient air monitoring networks (including AMTIC, state, and industry monitoring networks) were included in this assessment to provide context for modeled concentrations from TSCA sources as well as aggregate monitoring concentrations that reflect both TSCA sources and other sources.

Given the complexities of the exposure assessment of 1,3-butadiene in ambient air as previously described, multiple yet complimentary lines of evidence were considered to understand and contextualize the ambient air concentrations of 1,3-butadiene resulting from COUs. These evidence streams are summarized below and detailed in the following subsections:

1. **Modeled 1,3-Butadiene Concentrations from COUs:** This assessment uses EPA's [IIOAC](#) (accessed November 21, 2025) to model 1,3-butadiene ambient air concentrations near releasing facilities, based on reported 1,3-butadiene release data from the TRI for COUs as a first tier analysis (Section 2.2.3.1). In Tier II, EPA's [HEM v4.2](#) (accessed November 21, 2025) was used to obtain geographically refined estimates of 1,3-butadiene ambient air concentrations based on TRI releases, site-specific meteorological data, and 2020 U.S. census blocks and population data (Section 2.2.3.2). In the Tier III analysis, EPA conducted additional modeling with HEM using NEI release data.
2. **Measured 1,3-Butadiene Concentrations:** Monitoring data from several ambient air monitoring networks identified through EPA's systematic review process, peer review, and public comments and available to the Agency were used to provide context for modeled concentrations as well as aggregate concentrations of 1,3-butadiene in ambient air (Section 2.3.1). A comparison between modeled concentrations and monitored concentrations is provided in Section 2.3.2. In addition, a fenceline monitoring report from EPA's OAR is also discussed to provide additional context (Section 2.3.3.1)
3. **Relative Source Contributions In Ambient Air:** This assessment includes discussion of the 2020 Air Toxics Screening Assessment Tool ([AirToxScreen](#); accessed November 21, 2025) and analysis conducted by EPA's OAR to provide context for the relative contributions of 1,3-butadiene in ambient air from multiple source categories (Section 2.3.3.2), including sources associated with TSCA COUs and other sources.

2.1 General Population Exposure Scenarios

EPA expects the ambient air pathway to be the predominant human exposure pathway to 1,3-butadiene in the outdoor environment as shown in Figure 2-1. In summary, 1,3-butadiene is released from industrial facilities as uncontrolled fugitive releases such as process equipment leaks, process vents, building windows, building doors, and roof vents. It is also released from industrial facilities as stack releases, which may be either uncontrolled (*e.g.*, direct releases out a stack) or controlled with a pollution control device (*e.g.*, baghouse, scrubber, thermal oxidizer). Once released to ambient air, 1,3-butadiene can move off-site into surrounding areas where human (general) populations may be subsequently exposed through inhalation. This ambient air exposure assessment focuses on exposures to a subset of the general population living near industrial facilities that are releasing 1,3-butadiene to the ambient air.

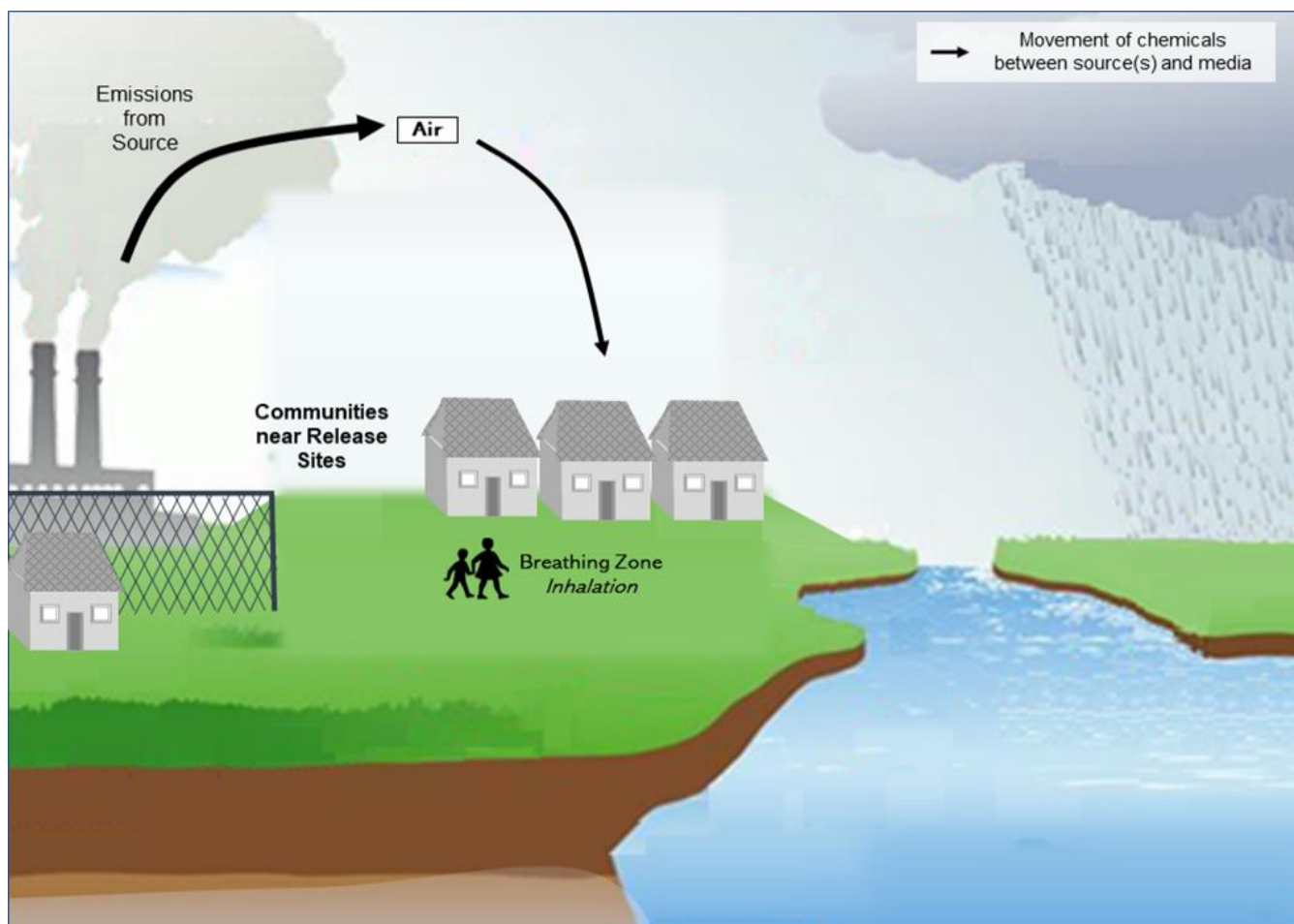


Figure 2-1. Industrial Releases to the Environment and Pathways by Which Exposures of the General Population to 1,3-Butadiene May Occur

2.2 Inhalation Exposure Modeling Assessment

2.2.1 Environmental Releases to Air

Industry-reported air releases of 1,3-butadiene from industrial sources were extracted from TRI for reporting years 2016 through 2021 as described in the *Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* ([U.S. EPA, 2025c](#)). Facilities required to report to TRI must meet several reporting criteria, including the number of full-time employees, specific North American Industry Classification System (NAICS) codes, and a chemical threshold of manufacturing and processing (>25,000 pounds [lb]) or otherwise using 1,3-butadiene (>10,000 lb). Each facility subject to the TRI reporting rule must report either using a Form R or a Form A. Facilities reporting using a Form R must report annually the volume of chemical released to the environment (*i.e.*, surface water, air, or land) and/or managed through recycling, energy recovery, and treatment (*e.g.*, incineration) from the facility. Facilities may submit a Form A if the volume of chemical manufactured, processed, or otherwise used does not exceed 1,000,000 lb (lb/year) and provided the total annual reportable releases do not exceed 500 lb/year. The TRI dataset for 1,3-butadiene included 225 Form R reporting facilities across the 6 years of reporting data queried, equaling a total of 1,169 individual reported releases. Total annual fugitive releases for the Form R reporters ranged from 140,613 to 167,970 kg, while total annual stack releases for the Form R reporters ranged from 325,629 to 471,927 kg.

Once reported release data are extracted, each TRI facility reporting 1,3-butadiene releases are assigned to an occupational exposure scenario (OES). OESs are established based on similarities or differences in release and exposure sources, worker activities, and use patterns occurring at a facility. OESs are then mapped to COUs shown in Table 1-1 of the *Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* ([U.S. EPA, 2025c](#)), which, along with its associated supplemental files, provide detailed descriptions of the methods used to extract release data and summarize the individual facility releases. In addition to the TRI-reported releases, the Agency also modeled ambient concentrations for an additional OES related to adhesives and sealants based on EPA-estimated releases detailed in the *Environmental Releases and Occupational Exposures Assessment* ([U.S. EPA, 2025c](#)). For the purposes of this assessment, the modeled air concentrations are based on facility-specific releases; therefore, general population exposures are associated with facility-specific assigned OESs and COUs.

2.2.2 Human Health Hazard

Sensitive organ-level endpoints are unlikely to result from a single exposure at concentrations relevant to human exposures. Therefore, EPA expects low risks to the general population from acute exposures for all COUs. The Agency evaluated chronic non-cancer risk for general population chronic exposure using the human equivalent concentration (HEC) of 2.5 ppm (5,500 $\mu\text{g}/\text{m}^3$) for reduced fetal weight with a benchmark margin of exposure (MOE) of 30. EPA evaluated lifetime cancer risk using the general population inhalation unit risk (IUR) of 0.0129 per ppm (5.83×10^{-6} per $\mu\text{g}/\text{m}^3$). See the *Human Health Hazard Assessment for 1,3-Butadiene* ([U.S. EPA, 2025e](#)) for more details on the human health hazard values.

2.2.3 Tiered Approach for General Population Exposure and Risk Estimates for General Population

EPA conducted a quantitative exposure assessment for the air pathway to evaluate both non-cancer and cancer risks for the general population using a tiered approach. For this fit-for-purpose general population exposure assessment, EPA targeted its review of environmental releases to point sources and did not review road, non-road, and other automotive exhaust information identified. This is because 1,3-butadiene produced from combustion sources is not assessed as an independent COU subcategory under TSCA in this assessment. The Agency focused its environmental release assessment on total facility emissions, which can include emissions from both uses of 1,3-butadiene and combustion sources at the same facility or, potentially, only combustion sources from that facility. However, context for other sources of 1,3-butadiene is discussed in Section 2.3.3.2.

For the Tier I analysis, EPA used the IIOAC Model to (1) estimate 1,3-butadiene ambient air concentrations across radial distances between 100 to 1,000 m from release points using industry-reported release data from TRI (2016–2021), and (2) presented a range of modeled concentrations across all reporting years for each facility. The ambient air concentrations modeled with IIOAC were used for the risk calculations for chronic non-cancer MOEs and inhalation cancer risk estimates. If the calculated MOEs were below the benchmark of 30 or if the calculated lifetime cancer risk estimates were at or above 1 in a million (1×10^{-6}), then EPA conducted refined analyses to further characterize exposures and associated risks.

Based on the Tier I results from IIOAC, non-cancer risks were not expected for the general population. However, there were cancer risk estimates at or above 1 in a million. Therefore, EPA moved forward to a Tier II analysis and used the HEM to refine 1,3-butadiene ambient air concentrations and estimated inhalation cancer risks across radial distances between 10 to 50,000 m from TRI facility releases. However, for purposes of exposure characterization and derivation of risk estimates, EPA is relying on radial distances greater than or equal to 100 meters. In response to Science Advisory Committee on

Chemicals (SACC) and public comments, aggregate non-cancer risks were also considered based on the HEM radial distance-modeled concentrations of 1,3-butadiene.

EPA focused on modeled air concentrations for the following distances: 100 m, 100 to 1,000 m, and 1,000 m. These distances allow for comparison to the IIOAC screening results and are consistent with the community populations living near facilities as described in the fenceline methodology ([Draft Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities Version 1.0](#); accessed November 21, 2025).

In addition to modeling ambient air concentrations at radial distances, HEM was used to model annual average ambient air concentrations and to estimate cancer risks at the centroid of census blocks within 50,000 m from TRI facility release points. Census block-based results are aggregated across facilities; that is, if there were two or more TRI facilities within 50,000 m from a census block, then the modeled concentrations from each facility release were added together to calculate an aggregate cancer risk estimate at that census block.

Based on the Tier II results from HEM, aggregate non-cancer risks were not expected for the general population. However, there were cancer risk estimates at or above 1 in a million. Therefore, EPA moved forward to a Tier III analysis and used HEM to model NEI release data. The Tier III analysis consisted of (1) using a subset of the 2017 and 2020 NEI facility releases corresponding to the TRI facilities that resulted in census block cancer risk estimates at or above 1 in a million in the Tier II analysis; and (2) using those facilities' emission unit-specific stack parameters, as well as local meteorological data and fugitive area source parameters when reported, as inputs into the HEM Model for further refined modeling and risk estimate results. Figure 2-2 illustrates the tiered approach EPA used for this 1,3-butadiene general population risk assessment. The Tier III results are presented in Section 5.3.4 of the *Risk Evaluation for 1,3-Butadiene*.

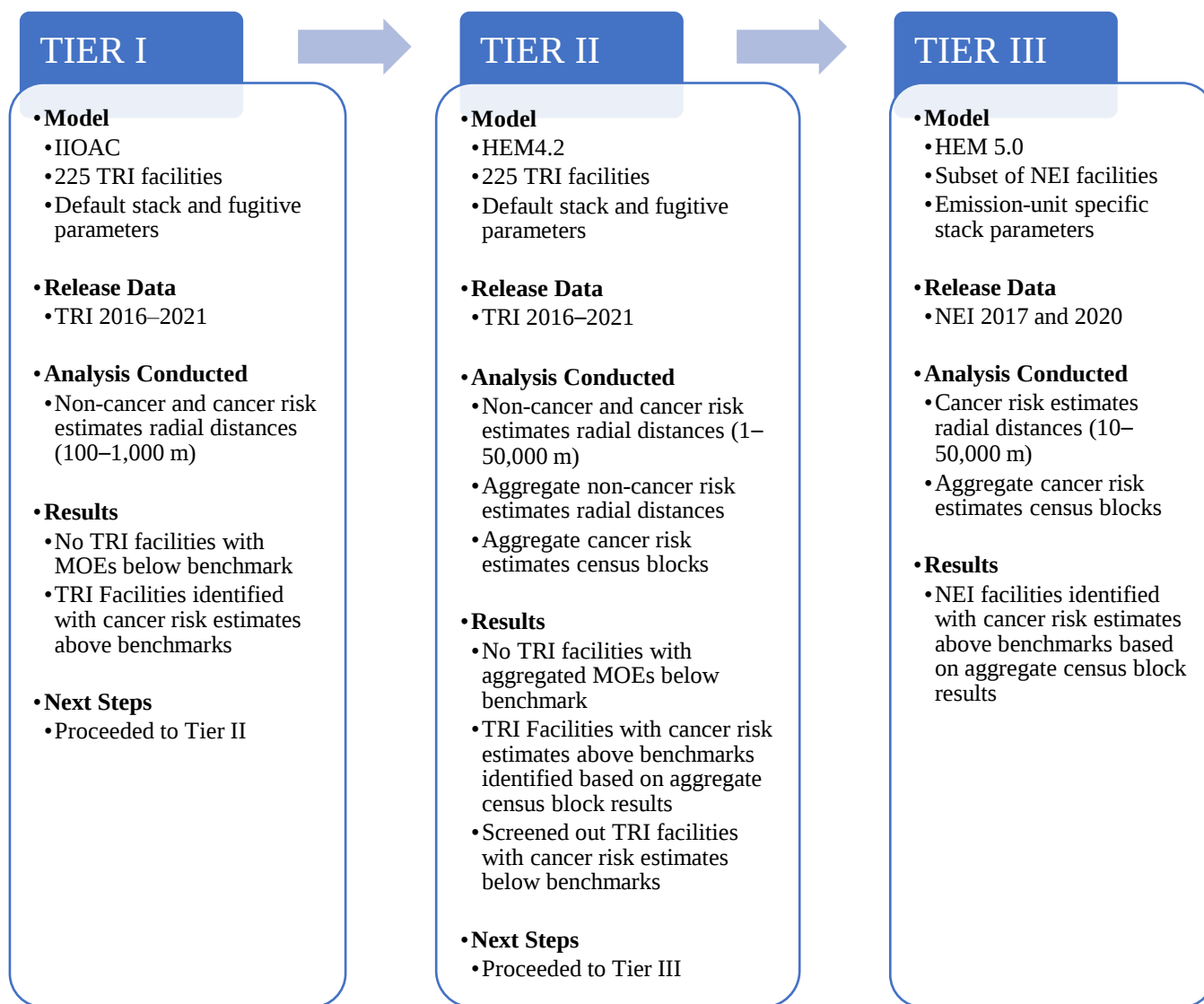


Figure 2-2. Tiered Analysis for the 1,3-Butadiene General Population Exposure and Risk Assessment

2.2.3.1 Tier I: IIOAC Inhalation Risks by Radial Distances from TRI Releases

For the Tier I analysis, EPA modeled ambient air concentrations of 1,3-butadiene using IIOAC- and industry-reported releases from TRI (2016–2021) at three distances from industrial release points (100, 100–1,000, and 1,000 m). Modeled concentrations output from IIOAC (95th percentile and mean for the 100–1,000 m area distance) were assumed to equal exposure concentrations and used to derive associated MOEs and cancer risk estimates using the equations found in Appendix A.1.4. No calculated non-cancer inhalation MOE was below the benchmark of 30 for any IIOAC-modeled concentrations from 100 to 1,000 m across all TRI facilities. Several cancer risk estimates based on IIOAC 95th percentile- and mean-modeled concentrations were at or above the 1 in a million. Based on these screening level findings, EPA conducted a refined Tier II analysis.

See Appendix A for more details on the IIOAC-modeled concentrations and risk estimate results. For full IIOAC modeling concentrations and risk estimate results, see the supplemental file: *Integrated Indoor Outdoor Air Calculator (IIOAC) TRI 2016–2021 Exposure and Risk Analysis for 1,3-Butadiene* (U.S. EPA, 2025f).

2.2.3.2 Tier II: HEM Inhalation Risks from TRI Releases

Because the cancer risk estimates from the Tier I IIOAC analysis were at or above 1 in a million, EPA moved forward to a Tier II analysis utilizing HEM and the TRI dataset to conduct a more geographically refined analysis of ambient air concentrations, exposures, and associated risks using localized meteorological data and site-specific days of operation. This Tier II analysis used the single highest individual facility-reported releases across all 5 years of reported releases evaluated. EPA therefore evaluated 225 facilities in the Tier II analysis for lifetime exposures (and associated cancer risks). In addition, although the Tier I IIOAC analysis resulted in all non-cancer inhalation MOEs above the benchmark, EPA included an aggregate assessment for non-cancer risks utilizing a previously peer-reviewed methodology to determine aggregate exposure (see the [Final Risk Evaluation for 1,4-Dioxane](#); accessed November 21, 2025) in response to SACC and public comments and recommendations on the *Draft Risk Evaluation for 1,3-Butadiene* ([U.S. EPA, 2024h](#)).

2.2.3.2.1 Tier II: Aggregate Non-Cancer Risk Estimates

To evaluate aggregate non-cancer risk estimates, EPA looked for the lowest MOE calculated based on the HEM 95th percentile-modeled concentrations at 100 m since this represents the most conservative non-cancer risk estimate. The Firestone Polymer facility (TRI ID 70602FRSTNLA108), associated with the Processing – plastics and rubber polymerization COU/OES, had the lowest MOE of 60.3, which is twice the benchmark of 30. Because this facility resulted in the lowest calculated MOE, EPA based its aggregate exposure assessment for non-cancer risk on this facility and all other facilities located within 10 km. EPA identified seven other TRI facilities located in proximity to the Firestone Polymer facility (circled in Figure 2-3). EPA then calculated a conservative aggregate total exposure concentration by summing the 95th percentile-modeled concentration at 100 m from all eight facilities. This is a conservative estimate because it assumes exposure is occurring at 100 m from all eight facility releases simultaneously and from the same release point, even though facility locations and releases do not spatially or temporally align. EPA used the aggregated modeled concentration from all eight facilities to derive an aggregate MOE. The resulting aggregate MOE was 47.6, which is above the non-cancer benchmark of 30. Therefore, based on this conservative aggregate assessment, non-cancer risks are not expected from inhalation exposure to 1,3-butadiene from facility releases and no further refinements were conducted.

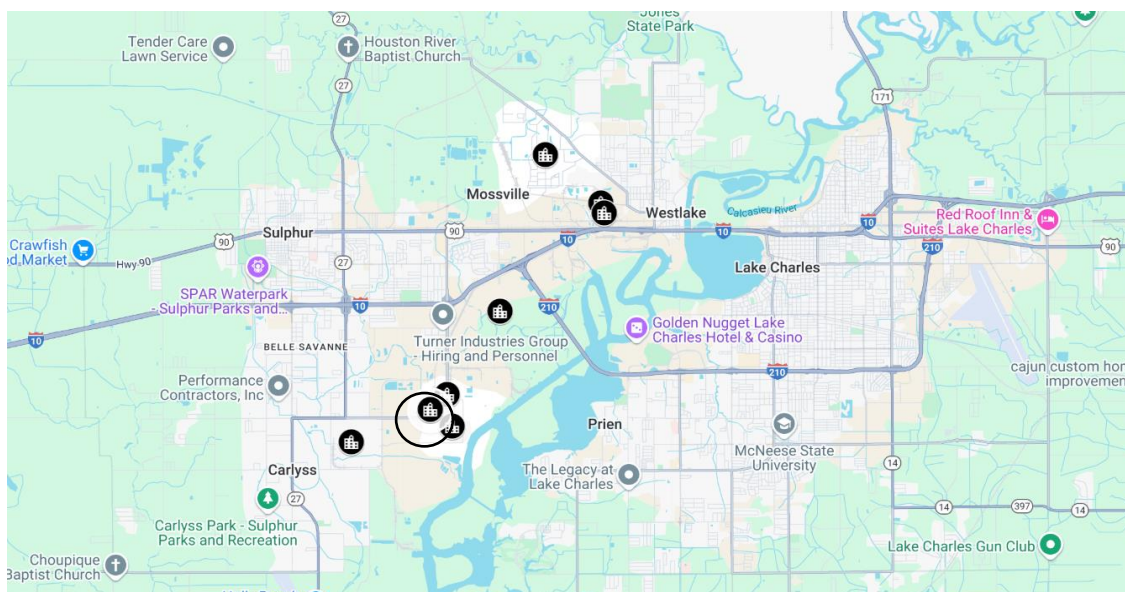


Figure 2-3. Map of TRI Facilities for Aggregate Non-Cancer Analysis

To evaluate cancer risks in the Tier II analysis, EPA used HEM to model the highest individual facility releases across all TRI reporting years considered. While this can result in aggregating exposures and associated risks which do not temporally align (*e.g.*, highest stack release occurred in 2016 for an individual facility but the highest fugitive release occurred in 2018 for the same facility) using this conservative approach, 60 of the 225 TRI facilities evaluated resulted in cancer risk estimates at or above 1 in a million.

Based on the aggregate census block cancer risk estimates and the conservative modeling approach, there were a total of 9,596 census blocks located around the 225 TRI facilities with an aggregate cancer risk estimate at or above 1 in a million. Census block ID 66001009 had the highest aggregate cancer risk estimate of 1.04×10^{-4} (1.04 in 10,000). This census block is in Groves, Texas (Port Arthur), with 20 TRI facilities releasing 1,3-butadiene located within 50 km. Although 20 facilities contribute to this aggregate cancer risk estimate at this census block, a single facility contributes about 94 percent of the total aggregated cancer risk estimate with a facility cancer risk estimate of 9.8×10^{-5} (9.8 in 100,000). This is the closest facility of the 20 facilities; located within 200 m of this census block and is categorized under the Manufacture – manufacturing COU/OES.

See Appendix A for more details on the HEM TRI-modeled concentrations and risk estimate results. For full HEM TRI modeling results, see the supplemental file: *Human Exposure Model (HEM) TRI 2016–2021 Exposure and Risk Analysis for 1,3-Butadiene* ([U.S. EPA, 2025d](#)).

A source of uncertainty in these analyses is the assumption that the TRI-reported stack releases from each facility are from a standardized stack of 10-meters in height and fugitive releases are from a 3-meter height with a source area of 10×10 m as described in Appendix A. This assumption may not fully represent actual stack or fugitive release heights or fugitive source dimensions at a given facility.

Another source of uncertainty is how representative the total single facility-wide release reported to TRI is of the actual spatial alignment of release point(s) across each facility evaluated with HEM. Using the total single facility-wide release as an input to HEM requires EPA to assume the 1,3-butadiene release occurs from a single stack and fugitive release point within the facility. This release point is spatially placed at the latitude/longitude reported to TRI, which may not represent the actual release point location. This uncertainty may be a minimal for small facilities releasing 1,3-butadiene because they may only have a single release point and that release point may be near the latitude/longitude reported in TRI. However, for large facilities, which can span multiple acres, the uncertainty may be greater because such facilities may have multiple release points across multiple acres; therefore, a single release point at a single latitude/longitude may not spatially represent the actual releases from each release point within the respective facility. This uncertainty, considering the potential spatial alignments adjustments, can result in either an over- or under-estimation of modeled concentrations (and associated risk estimates) at any given modeled distance or census block based on the HEM outputs.

As described in Section 2.3.3 of the *Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* ([U.S. EPA, 2025c](#)), NEI release data were assessed for the 2017 and 2020 reporting years. NEI release data are typically reported at the individual emission unit level and may include emission unit-specific release parameters (*e.g.*, stack height, stack diameter, area for fugitive release source) and emission unit-specific latitude and longitude coordinates. When emission unit-specific release parameter information is provided in the NEI dataset, EPA used this information as direct inputs to the HEM. When emission unit-specific release parameter information was not provided in the NEI dataset, EPA used the default release parameters described in the Tier I and II analyses. This granularity of data available in NEI allows for additional refinement of modeled ambient air concentrations and resulting

risks compared to TRI release data, when reported to NEI.

Because cancer risk estimates based on HEM modeling with the TRI dataset were at or above 1 in a million, EPA conducted a refined Tier III analysis using HEM with the NEI dataset for the 60 TRI facilities that resulted in census block cancer risk estimates at or above 1 in a million identified in the Tier II analysis. EPA selected these TRI facilities for further refined modeling based on the census block cancer risk estimates rather than radial distance risk estimates. This is because the census block estimates consider actual populations residing within proximity to these facilities while radial distances often require further investigation to determine whether populations actually reside at those radial distances. However, for the Tier III analysis, EPA discusses both radial distance results and census block results with the NEI release data in Section 5.3.4 of the *Risk Evaluation for 1,3-Butadiene*.

2.3 Other Assessments

To validate IIOAC- and HEM-modeled concentrations based on TRI and NEI release data, a comparison between modeled concentrations and the AMTIC monitoring concentrations presented in the *Environmental Media Concentrations for 1,3-Butadiene* is discussed in Section 2.3.2 of this TSD. In addition, other fence-line monitoring and modeling assessments conducted by EPA OAR, including the AirToxScreen, are discussed and referenced for additional context for other sources of 1,3-butadiene in Section 2.3.3.

2.3.1 Measured Ambient Air Concentrations

The Agency identified and summarized monitoring data for 1,3-butadiene extracted from EPA's AMTIC archive ([U.S. EPA, 2022](#))—a collection of data from air monitoring networks across the United States. EPA also identified and summarized measured data from peer-reviewed literature, gray literature, and databases that were included in the Agency's systematic review process detailed in the *Systematic Review Protocol for 1,3-Butadiene* ([U.S. EPA, 2025i](#)). For the purposes of this general population exposure assessment, EPA focused comparison of its modeled air concentrations to the monitored concentrations in the AMTIC archive due to the representativeness of the AMTIC archive data of ambient air concentrations of 1,3-butadiene across the United States. While the monitoring data captured by EPA's systematic review process also provide ambient concentrations of 1,3-butadiene, the studies identified were limited and varied by sample size, geographic location, and temporally (*i.e.*, time of year samples were collected, sampling durations and sample collection methods).

The AMTIC archive includes ambient air quality monitoring data collected for high priority air pollutants and is overseen by the EPA Ambient Air Monitoring Group (AAMG). Submitted air quality monitoring data must meet the collection and quality assurance criteria set by AMTIC to be included in the database. Ambient air concentration data were pulled in April of 2025 capturing monitoring data from 2016 to 2022 to be consistent with TRI reporting years evaluated in this assessment. The AMTIC monitoring data includes all sources contributing to ambient concentrations of 1,3-butadiene and cannot be attributed to a single TSCA COU for purposes of risk characterization or risk conclusions in the 1,3-butadiene risk evaluation. However, these monitoring data are used in this assessment to help contextualize ambient concentrations of 1,3-butadiene. They also provide support in the weight of scientific evidence to provide additional confidence in modeled results and use of those modeled results, which are directly associated with TSCA COUs, for exposure and risk characterizations, risk determination, and regulatory decision-making.

EPA considered both the 24- and 1-hour monitoring values within the AMTIC archive for this assessment. An overall summary of the counts of samples, non-detects (NDs), and below method limit of detection (MDL) (*i.e.*, <MDL for the 24- and 1-hour monitoring values are presented in Table 2-1 and

Table 2-2, respectively).

Across the 2016 to 2022 monitoring years, the 24-hour monitored concentrations ranged from ND to 267.3 $\mu\text{g}/\text{m}^3$; NDs are considered to be 0.0 $\mu\text{g}/\text{m}^3$. The mean 24-hour concentration ranged from 8.0×10^{-2} to 0.15 $\mu\text{g}/\text{m}^3$ (0.22–0.43 $\mu\text{g}/\text{m}^3$, excluding NDs / <MDLs). The median 24-hour concentration ranged from 0.00 to 0.02 $\mu\text{g}/\text{m}^3$ (0.08–0.11 $\mu\text{g}/\text{m}^3$, excluding NDs/<MDLs). The minimum concentration was ND (2.0×10^{-3} $\mu\text{g}/\text{m}^3$, excluding NDs / <MDLs).

Across the 2016 to 2022 monitoring years, the 1-hour monitored concentrations ranged from ND to 3,045 $\mu\text{g}/\text{m}^3$; again, NDs are considered to be 0.0 $\mu\text{g}/\text{m}^3$. The mean 1-hour concentration ranged from 0.12 to 0.28 $\mu\text{g}/\text{m}^3$ (0.23–0.56 $\mu\text{g}/\text{m}^3$, excluding NDs / <MDLs). The median 1-hour concentration ranged from 4.0×10^{-2} to 5.0×10^{-2} $\mu\text{g}/\text{m}^3$ (9.0×10^{-2} to 0.16 $\mu\text{g}/\text{m}^3$, excluding NDs / <MDLs). The minimum concentration was ND (4.0×10^{-3} $\mu\text{g}/\text{m}^3$, excluding NDs / <MDLs).

Further discussions on NDs and <MDLs are detailed below in Section 2.3.2 and in Section 3.1.2 of the *Environmental Media Concentrations for 1,3-Butadiene*. For more details on monitoring data, including AMTIC and other monitoring networks, as well as measured ambient air concentrations from systematic review and detailed summary stats that include ND and less than MDL values, see the *Environmental Media Concentrations for 1,3-Butadiene* ([U.S. EPA, 2025b](#)).

Table 2-1. Sample Statistics for 24-Hour AMTIC Archive Dataset

Year	MDL ($\mu\text{g}/\text{m}^3$)	# Samples	# ND	% ND	# <MDL	% <MDL
2016	2.0E-03 to 1.1	1.4E04	6,987	49	1,710	12
2017	2.0E-03 to 1.1	1.4E04	7,468	52	1,627	11
2018	2.0E-03 to 1.1	1.4E04	7,560	53	1,849	13
2019	4.0E-03 to 1.1	1.3E04	7,148	57	1,209	9.6
2020	1.3E-02 to 0.93	1.1E04	6,179	54	1,578	14
2021	4.0E-03 to 0.55	1.2E04	6,092	51	1,881	16
2022	4.0E-03 to 1.1	1.1E04	4,579	44	2,588	25
MDL = method detection limit; ND = non-detect						

Table 2-2. Sample Statistics for 1-Hour AMTIC Archive Dataset

Year	MDL ($\mu\text{g}/\text{m}^3$)	# Samples	# ND	% ND	# <MDL	% <MDL
2016	5.5E-02	2.3E05	5.7E04	24	5.5E04	24
2017	5.5E-02	2.0E05	4.2E04	21	6.1E04	30
2018	5.5E-02 to 0.22	2.0E05	4.1E04	21	1.1E05	56
2019	2.3E-02 to 0.22	2.2E05	4.2E04	19	1.3E05	59
2020	1.6E-02 to 0.27	1.3E05	3.6E04	28	4.0E04	31
2021	2.0E-02 to 0.22	3.6E05	7.8E04	21	1.1E05	30

Year	MDL (ug/m3)	# Samples	# ND	% ND	# <MDL	% <MDL
2022	1.3E-02 to 0.27	3.9E05	9.8E04	25	1.3E05	34
MDL = method detection limit; ND = non-detect						

2.3.2 Modeled and Monitoring Concentrations Comparison

IIOAC- and HEM-modeled concentrations based on TRI 2016 to 2021 release data were compared to AMTIC monitoring data. In addition, EPA conducted further refined modeling with HEM for the TRI facilities that had corresponding NEI 2017 and 2020 releases (*i.e.*, facilities that reported to both TRI and NEI databases; 201 of the 225 TRI facilities also reported to NEI). See the supplemental file *Human Exposure Model (HEM) NEI 2017 and 2020 Exposure Analysis for 1,3-Butadiene* ([U.S. EPA, 2025d](#)) for more details. Details and tables of modeled concentrations from IIOAC and HEM modeling using TRI and NEI release data are detailed in Appendix A and Appendix B. Figure 2-4 summarizes and presents a comparison of the 1,3-butadiene modeled concentrations from IIOAC and HEM (100, 100–1,000, and 1,000 m distances) along with the AMTIC archive 24- and 1-hour monitoring data. From left to right, the IIOAC mean-modeled concentrations are generally higher than the HEM 50th percentile-modeled concentrations when both models used TRI releases as inputs. The differences between these modeled concentrations are attributable to the facility-specific information (*e.g.*, facility location, latitude/longitude; geographical considerations; local meteorology) used as inputs to HEM, rather than the conservative predefined inputs used for IIOAC. When considering HEM-modeled concentration based on NEI release data, the differences are further pronounced due to the emission unit-specific information (stack height, exit velocity, temperature, fugitive area size, etc.), which are not available with TRI release data.

When comparing modeled concentrations from all modeling performed in this assessment (IIOAC-TRI, HEM-TRI, HEM-NEI) to the AMTIC archive monitored concentrations, the modeled concentrations had a smaller range across all concentrations and distances, and lower minimum and maximum values. However, overall, the mean modeled concentrations were similar or within the same order of magnitude as the mean monitored concentrations—indicating some agreement between modeled and monitored concentrations. The $\mu\text{g}/\text{m}^3$ compared to the mean AMTIC 24-hour monitoring concentration of $0.31 \mu\text{g}/\text{m}^3$. In general, refining from IIOAC-TRI to HEM-TRI and then to HEM-NEI resulted in a lower maximum, mean, and median values. This is consistent with the AECOM Evaluation of EPA TSCA Screening Level Approach presentation that demonstrated refined modeling using NEI release data resulted in lower modeled air concentrations when compared to modeled air concentrations using TRI release data for a case study facility in Deer Park Houston, Texas (see Docket [EPA-HQ-OPPT-2018-0451-0076](#) for more details); a peer-reviewed study is also available ([Masoud et. al, 2025](#)). Masoud and colleagues also compared modeled concentrations for this facility to a nearby Houston regional monitoring station and found that modeled maximum concentrations based on NEI release data were within the same order of magnitude with the annual average measured concentrations: 0.2 ppb modeled concentration compared to 0.18 ppb measured concentration for the 2019 year and 0.21 ppb modeled concentration compared to 0.23 ppb measured concentration for the 2021 year.

However, it is important to note that Figure 2-4 compares the 50th percentile-modeled concentrations at select distances to detected AMTIC monitoring concentrations (*i.e.*, excludes all the samples that were reported as NDs or <MDL). Including all NDs and less than MDLs results in a lower mean, median, and minimum for monitored values because NDs are equal to $0.0 \mu\text{g}/\text{m}^3$ and less than MDLs are reported as non-zero values but below the MDL, which ranged from 2.0×10^{-3} to $1.1 \mu\text{g}/\text{m}^3$. When including NDs

and less than MDLs, the monitored concentrations still remain similar and are within the same order of magnitude with the HEM-modeled concentrations overall. When including ND and less than MDL values, mean 24-hour concentrations ranged from 8.0×10^{-2} to $0.15 \mu\text{g}/\text{m}^3$ compared to the mean 50th percentile HEM-modeled concentration using NEI release data at the 100 to 1,000 m area distance of $0.25 \mu\text{g}/\text{m}^3$.

EPA acknowledges that the modeled and monitored concentrations are not necessarily directly comparable because air monitoring stations are (1) located throughout the United States in different topographical settings (urban, suburban, rural); (2) at distances other than those compared in Figure 2-4; (3) specific to a select moment in time, location, season, and immediate weather conditions; and (4) representative of total ambient concentrations from all contributing sources (*i.e.*, COU-specific sources and other sources not within the scope of this assessment, including vehicular mobile sources, tobacco smoke, residential wood burning, and fires). In contrast, modeled concentrations are COU-specific, represent concentrations in defined topographical settings with local meteorological data at defined distances from the releasing source, and include assumptions of continuous releases over time and season. While these differences need to be considered when comparing modeled to monitored data in precise detail, a general national comparison of modeled and monitored concentrations as presented above is appropriate to contextualize and ground truth modeled concentrations. Given more time for future TSCA risk evaluations, EPA could further minimize differences between modeled and monitored concentrations by refining this analysis to consider the latitude and longitude of facilities and monitoring sites in proximity, concentrations at approximate distances of monitoring sites from releasing facilities, and other factors to allow more direct comparisons.

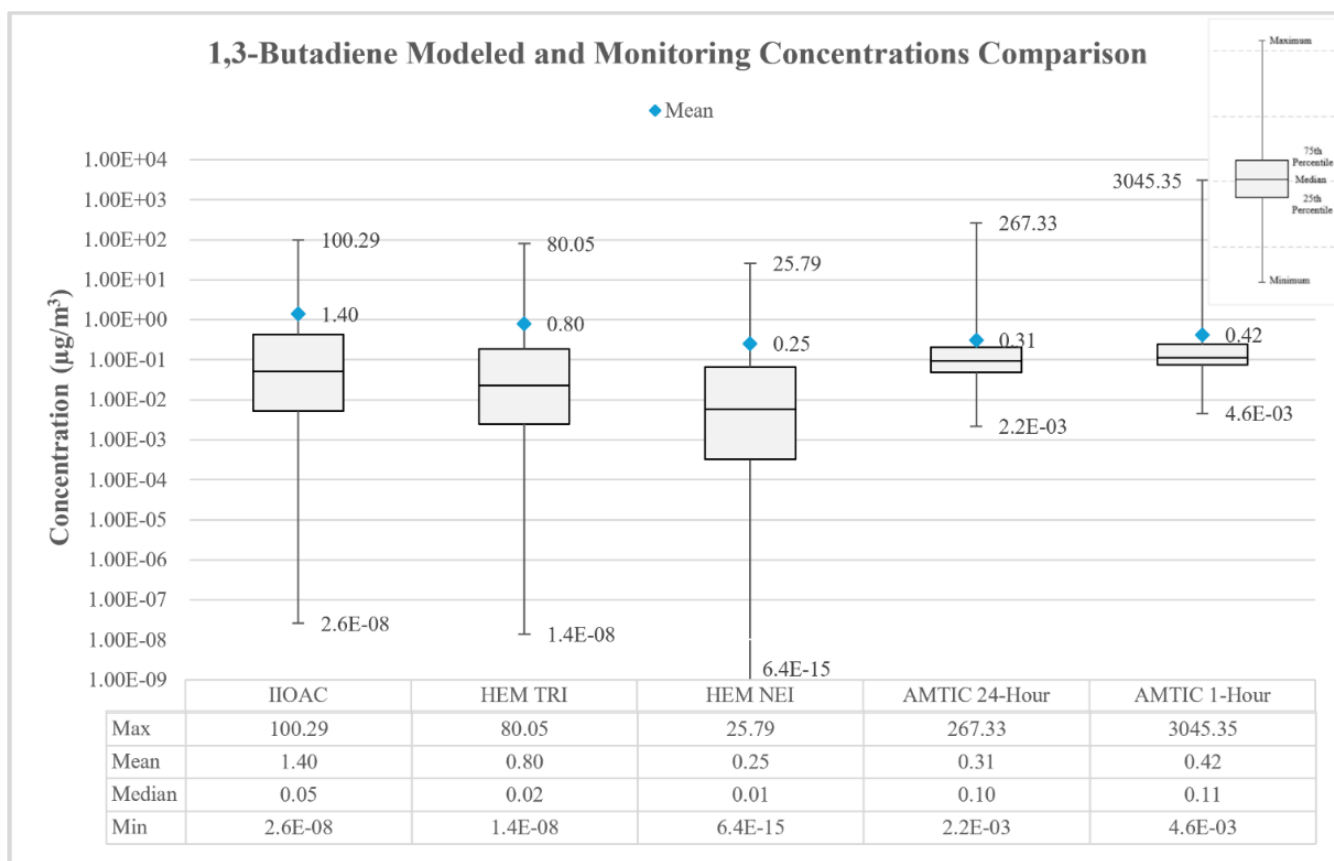


Figure 2-4. Comparison of 1,3-Butadiene Modeled and Monitoring Concentrations

*IIOAC modeling data presented based mean concentrations at 100 to 1,000 m (2016–2021 TRI Release Data)

*HEM TRI modeling data presented based on 50th percentile concentrations at 100 to 1,000 m (2016–2021 TRI Release Data) for 225 TRI facilities

*HEM NEI modeling data presented based on 50th percentile concentrations at 100 to 1,000 m (2017 and 2020 NEI Release Data) for 201 NEI facilities that correspond to the 225 TRI facilities

*AMTIC monitoring data presented based on 24- and 1-hour detected values (*i.e.*, without NDs and below MDL)

In addition, EPA evaluated a study referenced by the SACC ([Padilla et al., 2024](#)), which conducted a nationwide comparison between AMTIC monitoring concentrations and modeled concentrations from two EPA sources: (1) Risk-Screening Environmental Indicators (RSEI) geographic microdata that provide high resolution (810-meter grid) concentration estimates from industry sources that report to the TRI and AirToxScreen, which expands emissions inputs beyond TRI-covered sources to include additional industry point sources; and (2) non-industry nonpoint sources. AirToxScreen is further discussed in Section 2.3.3.2. The study concluded that there is an overall trend across all 79 hazardous air pollutants (HAPs) that monitored concentrations tend to be higher than modeled concentrations. Notably, out of the 79 HAPs, 1,3-butadiene resulted in the lowest bias with a median monitored to modeled bias ratio of 1.3; along with a median of 80 percent of monitoring measurements across the 360 monitoring stations were non-detects and/or reported as below the MDL.

The study also selected two facilities: one in Houston, Texas, and one in Baton Rouge, Louisiana, as case studies to apply adjustment factors for risk estimates based on the measured to modeled bias ratios. In the case studies, the adjustment factor for 1,3-butadiene was 1.0 (*i.e.*, no adjustment because the median-modeled concentration [0.21 µg/m³] was higher than the median monitored concentration [0.15 µg/m³]). However, the supplemental information [Table S5](#) (accessed November 21, 2025) shows a median adjustment ratio of 1.1 for 1,3-butadiene. [Padilla et al. \(2024\)](#), demonstrates that, specifically for

1,3-butadiene, risk estimates based on modeled concentrations are not overestimating risk overall. The authors suggest that available monitoring data could be potentially used in risk assessments to quantify the relevant range of modeled-measured bias factors and applying them to modeled exposure estimates but noted the exposure models evaluated and similar modeling systems are the best available tools for large-scale, screening level risk assessments.

2.3.3 Monitoring Measurements and Modeling Concentrations by Previous EPA Assessments

2.3.3.1 National Emission Standards for Hazardous Air Pollutants (NESHAP)

1,3-Butadiene is a HAP that is subject to Clean Air Act (CAA) sections 112(d) and 112(f). As a result, many facilities evaluated in this TSCA risk evaluation for 1,3-butadiene are also subject to one or more National Emission Standards for Hazardous Air Pollutants requirements promulgated under section 112 of the CAA and codified in 40 CFR Part 63. Regulations codified under Part 63 are technology-based standards (considering the top 12% of controls in place across the country). Following promulgation of the technology-based emission standards under Part 63, the CAA requires EPA to conduct regular risk and technology reviews (RTR) by applicable source category, including residual risk reviews. These reviews evaluate whether the technology-based standards (once fully implemented) adequately reduce risks to below select benchmarks (*e.g.*, 1×10^{-6} , 1×10^{-5} , or 1×10^{-4}). These reviews shifted the promulgated standards from a technology-based standard to a risk-based standard. If risks are not below acceptable levels, the CAA provides EPA with the authority to revise the standards based on the risk findings to mitigate the ongoing unacceptable risk.

As part of the risk and technology review process for the Synthetic Organic Chemical Manufacturing Industry: National Emission Standards for Hazardous Air Pollutants – 40 CFR part 63, subparts F, G, H, I (often referred to as the “HON”), EPA’s OAR issued information requests, pursuant to section 114 of the CAA, in June 2021 and July 2022, requiring nine facilities (see Table 2-3) subject to the HON to conduct fenceline monitoring for six HAPs—including 1,3-butadiene—to collect and submit monitoring data to EPA. For eight facilities, fenceline monitoring samples for 1,3-butadiene were collected on a continuous 14-day sampling period for three consecutive periods for a total of 42 days between the months of April and July 2022. One facility collected biweekly samples from January 2022 to December 2024.

Additionally, EPA’s OAR conducted modeling of 2017 NEI-reported releases from those same nine facilities using EPA’s American Meteorological Society/Environmental Protection Agency Regulatory Model ([AERMOD](#); accessed December 1, 2025) to model concentrations of the six HAPs. While EPA modeled all six HAPs individually, for purposes of the RTR and the 40 CFR part 63 standards (which typically regulate total HAP), OAR aggregates all HAPs together to derive a whole-facility estimate of attributable risk. OAR compared fenceline monitoring concentrations obtained and submitted to EPA in accordance with the information requests to modeled concentrations using AERMOD and the NEI emissions. From that comparison, results show the fenceline monitoring concentrations obtained and submitted by industry tended to be higher than EPA’s modeled concentrations using AERMOD and based on the 2017 NEI release dataset. For this comparison, OAR compared the facility average-modeled concentrations (emission unit based) to facility averaged monitoring concentrations (*i.e.*, the average across all monitoring sites within each facility). In the report, OAR concluded that fenceline monitoring concentrations exceeded modeled concentrations. However, some facilities (*e.g.*, Dow Chemical Louisiana, Formosa Plastics, Indorama Ventures, Sasol Chemicals) reported many 1,3-butadiene samples below the MDL. For more details on this assessment, see Docket: [EPA-HQ-OAR-2022-0730-0091](#).

Table 2-3. List of Facilities for Fenceline Monitoring

Company	Facility	Address
BASF Corporation	Geismar Site	8404 River Rd. Geismar, LA 70734
Denka Performance Elastomer	LaPlace Facility	560 Hwy 44 LaPlace, LA 70068
The Dow Chemical Company	Louisiana Operations	21255 Hwy 1 Plaquemine, LA 70765
The Dow Chemical Company	Texas Operations Freeport	2301 N. Brazosport Blvd. Freeport, TX 75602
Eastman Chemical Company	Texas Operations	300 Kodak Blvd. Longview, TX 75602
Formosa Plastics Corporation	Point Comfort Plant	201 Formosa Dr. Point Comfort, TX 77978
Huntsman Petrochemical	Conroe Facility	5451 Jefferson Chemical Rd. Conroe, TX 77305
Indorama Ventures	Port Neches Plant	2102 Spur 136 Port Neches, TX 77651
Sasol Chemicals	Lake Charles Chemical Complex	2201 Old Spanish Trail Westlake, LA 70669
Union Carbide Corporation	Seadrift Operations	7501 State Hwy 185 North Seadrift, TX 77983
Union Carbide Corporation	St. Charles Operations	355 Hwy 3142 Hahnville, LA 70057

2.3.3.2 Air Toxics Screening Assessment Tool (AirToxScreen)

EPA also evaluated existing modeled data from the 2020 [AirToxScreen Assessment](#) (accessed November 21, 2025) conducted by OAR to provide context for the relative contributions to 1,3-butadiene ambient air concentrations from 38 source categories that include agriculture, residential wood burning and vehicular and other mobile sources. The 2020 AirToxScreen uses the Community Multiscale Air Quality ([CMAQ](#); accessed November 21, 2025) chemical transport model and the [AERMOD dispersion model](#) (accessed November 21, 2025) to estimate annual average outdoor ambient air concentrations across the United States using release data from the 2020 NEI database along with 2020 Census block information. Figure 2-5 shows modeled concentrations of 1,3-butadiene across the United States from all source categories. Table 2-4 provides a summary, by EPA Region, of 1,3-butadiene concentrations results from the AirToxScreen 2020 assessment. The AirToxScreen 2020 assessment results (concentrations) ranged from 3.75×10^{-7} to $4.05 \mu\text{g}/\text{m}^3$ with the lowest minimum concentration modeled in Region 10 (Alaska) and the highest maximum concentration modeled in Region 7 (Iowa).

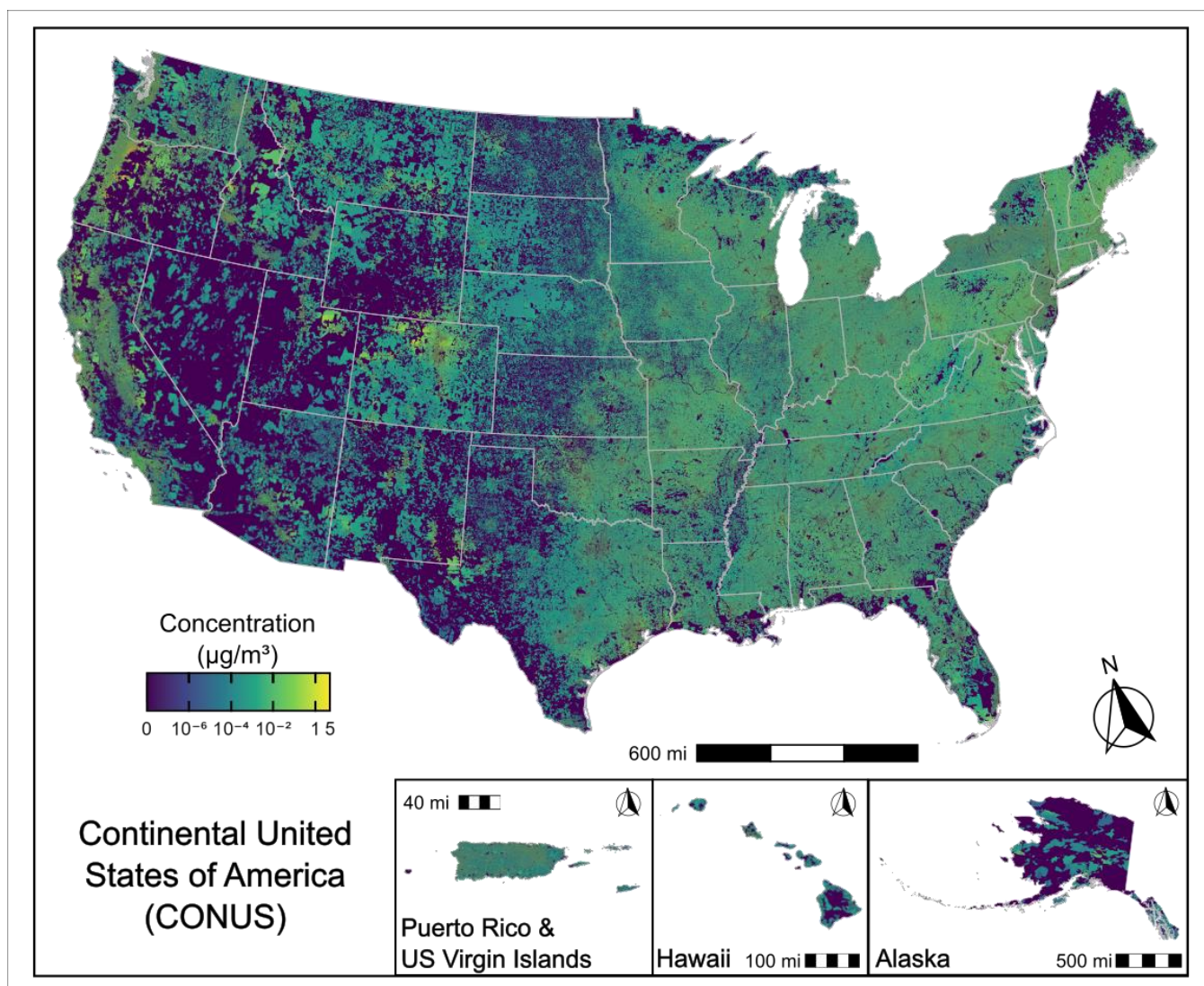


Figure 2-5. Map of Contiguous United States with AirToxScreen 2020 Results Based on NEI 2020 Releases Aggregated and Summarized by Census Block

Table 2-4. Summary of 1,3-Butadiene Ambient Modeled Concentrations from AirToxScreen 2020

Region	State	Count of Census Blocks	Population	Minimum	Median	Geomean	Mean	Maximum	Standard Dev.
1	CT	4.2E04	3.6E06	6.3E-03	2.2E-02	2.1E-02	2.2E-02	4.5E-02	7.0E-03
	MA	8.8E04	7.0E06	2.6E-03	2.1E-02	1.9E-02	2.2E-02	6.5E-02	9.0E-03
	ME	3.1E04	1.4E06	5.6E-04	1.8E-02	1.5E-02	1.9E-02	5.8E-02	1.1E-02
	NH	2.5E04	1.4E06	2.1E-03	2.2E-02	2.1E-02	2.4E-02	8.5E-02	1.2E-02
	RI	2.1E04	1.1E06	4.5E-03	2.3E-02	1.9E-02	2.1E-02	4.2E-02	8.0E-03
	VT	1.8E04	6.4E05	2.8E-03	1.4E-02	1.4E-02	1.5E-02	5.0E-02	7.0E-03
2	NJ	1.1E05	9.3E06	5.2E-03	2.2E-02	2.2E-02	2.4E-02	0.12	1.0E-02
	NY	2.3E05	2.0E07	1.7E-03	1.9E-02	1.6E-02	2.2E-02	0.11	1.6E-02
	PR	3.6E04	3.2E06	3.5E-04	6.0E-03	6.0E-03	7.0E-03	6.7E-02	4.0E-03
	VI	2,312	–	3.5E-05	2.0E-03	2.0E-03	2.0E-03	2.0E-02	1.0E-03
3	DC	4,500	6.9E05	2.9E-02	3.3E-02	3.4E-02	3.4E-02	4.0E-02	2.0E-03
	DE	1.5E04	9.9E05	1.9E-03	7.0E-03	9.0E-03	1.1E-02	8.8E-02	7.0E-03
	MD	6.5E04	6.2E06	8.9E-04	2.2E-02	1.7E-02	2.1E-02	9.7E-02	1.0E-02
	PA	2.8E05	1.3E07	2.2E-03	1.8E-02	1.6E-02	1.9E-02	5.9E-02	1.0E-02
	VA	1.2E05	8.6E06	7.3E-04	1.1E-02	1.1E-02	1.3E-02	0.16	9.0E-03
	WV	5.2E04	1.8E06	1.0E-03	9.0E-03	9.0E-03	1.1E-02	5.4E-02	7.0E-03
4	AL	1.3E05	5.0E06	1.6E-03	9.0E-03	9.0E-03	9.0E-03	0.63	5.0E-03
	FL	2.9E05	2.2E07	4.2E-05	7.0E-03	7.0E-03	8.0E-03	9.0E-02	4.0E-03
	GA	1.7E05	1.1E07	1.0E-03	8.0E-03	8.0E-03	1.0E-02	0.121	7.0E-03
	KY	9.2E04	4.5E06	2.1E-03	8.0E-03	8.0E-03	1.0E-02	0.142	6.0E-03
	MS	7.7E04	3.0E06	1.4E-03	5.0E-03	5.0E-03	6.0E-03	0.810	6.0E-03
	NC	1.7E05	1.0E07	2.2E-04	1.0E-02	9.0E-03	1.1E-02	0.292	6.0E-03
	SC	1.1E05	5.1E06	1.6E-03	7.0E-03	7.0E-03	8.0E-03	0.266	4.0E-03
	TN	1.3E05	7.0E06	1.1E-03	8.0E-03	8.0E-03	1.0E-02	0.119	6.0E-03
5	IL	2.8E05	1.3E07	1.8E-03	9.0E-03	9.0E-03	1.2E-02	1.350	1.0E-02
	IN	1.6E05	6.8E06	3.0E-03	9.0E-03	1.0E-02	1.1E-02	3.8E-02	6.0E-03
	MI	2.0E05	1.0E07	1.5E-04	1.1E-02	1.0E-02	1.3E-02	0.209	8.0E-03
	MN	1.4E05	5.7E06	2.0E-04	7.0E-03	8.0E-03	1.3E-02	6.0E-02	1.2E-02
	OH	2.2E05	1.2E07	1.0E-03	1.0E-02	1.1E-02	1.2E-02	0.721	7.0E-03
	WI	1.4E05	5.9E06	2.7E-04	9.0E-03	1.0E-02	1.1E-02	4.1E-02	7.0E-03

Region	State	Count of Census Blocks	Population	Minimum	Median	Geomean	Mean	Maximum	Standard Dev.
6	AR	8.8E04	3.0E06	1.5E-03	8.0E-03	8.0E-03	9.0E-03	0.10	6.0E-03
	LA	9.2E04	4.7E06	2.3E-04	6.0E-03	6.0E-03	7.0E-03	0.34	6.0E-03
	NM	5.7E04	2.1E06	9.1E-05	1.0E-02	8.0E-03	1.9E-02	0.23	2.2E-02
	OK	1.2E05	4.0E06	2.3E-04	7.0E-03	8.0E-03	1.0E-02	0.18	7.0E-03
	TX	4.5E05	2.9E07	1.1E-05	5.0E-03	6.0E-03	9.0E-03	1.3	1.5E-02
7	IA	1.2E05	3.2E06	1.5E-03	4.0E-03	4.0E-03	5.0E-03	4.5	1.2E-02
	KS	1.1E05	29E06	3.5E-04	4.0E-03	4.0E-03	7.0E-03	0.38	7.0E-03
	MO	1.7E05	6.2E06	2.1E-03	8.0E-03	9.0E-03	1.2E-02	3.6E-02	9.0E-03
	NE	8.0E04	2.0E06	1.2E-04	3.0E-03	3.0E-03	5.0E-03	0.15	6.0E-03
8	CO	1.0E05	5.8E06	1.5E-04	2.6E-02	1.6E-02	3.2E-02	0.63	2.9E-02
	MT	4.4E04	1.1E06	2.1E-04	5.0E-03	6.0E-03	1.1E-02	0.12	1.3E-02
	ND	4.0E04	7.8E05	2.8E-04	2.0E-03	2.0E-03	3.0E-03	8.9E-02	3.0E-03
	SD	4.1E04	8.9E05	1.7E-04	2.0E-03	2.0E-03	3.0E-03	2.5E-02	3.0E-03
	UT	4.7E04	3.3E06	5.6E-05	1.4E-02	9.0E-03	1.5E-02	0.19	1.1E-02
	WY	2.3E04	5.8E05	1.5E-04	5.0E-03	5.0E-03	8.0E-03	0.32	8.0E-03
9	AZ	1.1E05	7.1E06	2.9E-05	1.0E-02	6.0E-03	1.0E-02	0.19	7.0E-03
	CA	3.8E05	4.0E07	1.2E-04	2.1E-02	1.8E-02	2.4E-02	0.55	2.3E-02
	HI	1.0E04	1.5E06	1.7E-04	4.0E-03	4.0E-03	8.0E-03	8.6E-02	1.1E-02
	NV	3.5E04	3.1E06	3.8E-05	1.6E-02	1.0E-02	1.8E-02	0.10	1.5E-02
10	AK	1.1E04	7.2E05	<u>3.8E-07</u>	1.6E-02	9.0E-03	3.7E-02	0.65	5.2E-02
	ID	4.6E04	1.8E06	3.2E-04	1.1E-02	1.1E-02	2.7E-02	0.26	3.6E-02
	OR	7.9E04	4.2E06	2.8E-04	4.6E-02	4.1E-02	6.7E-02	1.4	9.0E-02
	WA	1.1E05	7.7E06	5.3E-04	2.7E-02	2.3E-02	3.5E-02	0.49	2.6E-02
All Regions		5.8E06	3.3E08	3.8E-07	1.2E-02	1.1E-02	1.5E-02	4.1	1.2E-02
<i>Italicized</i> = Lowest minimum across all EPA regions Bold = Highest maximum across all EPA regions									

Because NEI release data can be differentiated by source category, AirToxScreen outputs allow for a comparison of the relative contributions of different source categories (including both TSCA and other sources) to aggregate 1,3-butadiene ambient concentrations. EPA recognizes that activities related to fuel use and combustion are major sources of 1,3-butadiene and uses AirToxScreen to help characterize those emission sources. Figure 2-6 is a plot of the 1,3-butadiene concentrations for source categories related to fuel use and combustion and Figure 2-7 is a plot of the 1,3-butadiene concentrations for source categories not related to fuel use and combustion. For source categories related to fuel use and combustion, residential wood burning, wildfires, oil and gas, airports, and light duty vehicles were the highest contributing sources. For source categories not related to fuel use or combustion, stationary point sources, were the highest contributing sources. Industrial facilities that report to TRI and/or NEI fall under the stationary point source category and may have fuel use and combustion related activities. Industrial facilities may also fall under the other source categories, such as oil and gas, solvents and coatings, waste disposal, and industrial. See Table 2-13 of the 2020 AirToxScreen TSD ([U.S. EPA, 2025h](#)) for a list and descriptions of all 38 source categories.

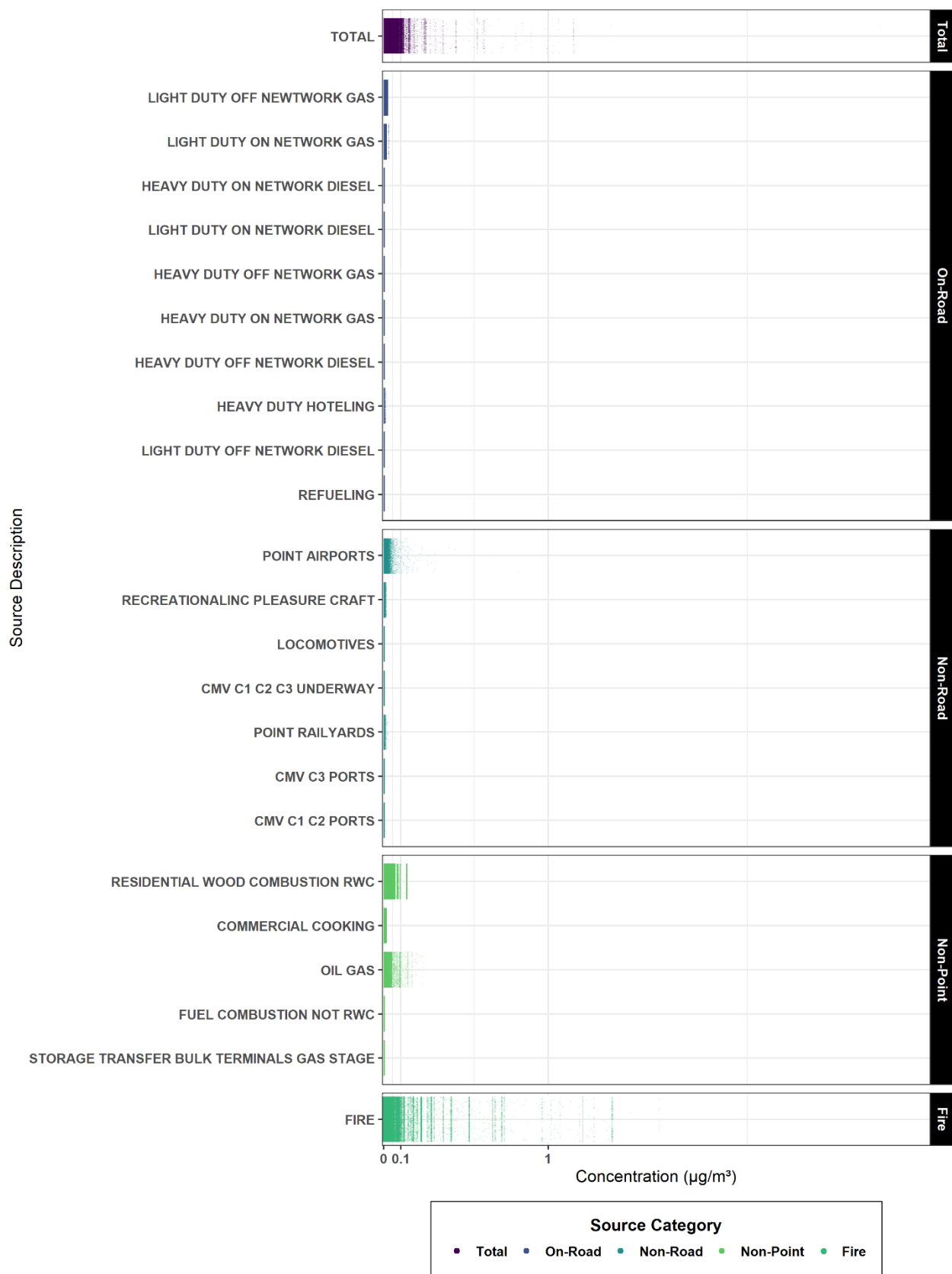


Figure 2-6. 1,3-Butadiene Ambient Air Concentrations Attributable to Fuel and Combustion Sources from AirToxScreen 2020

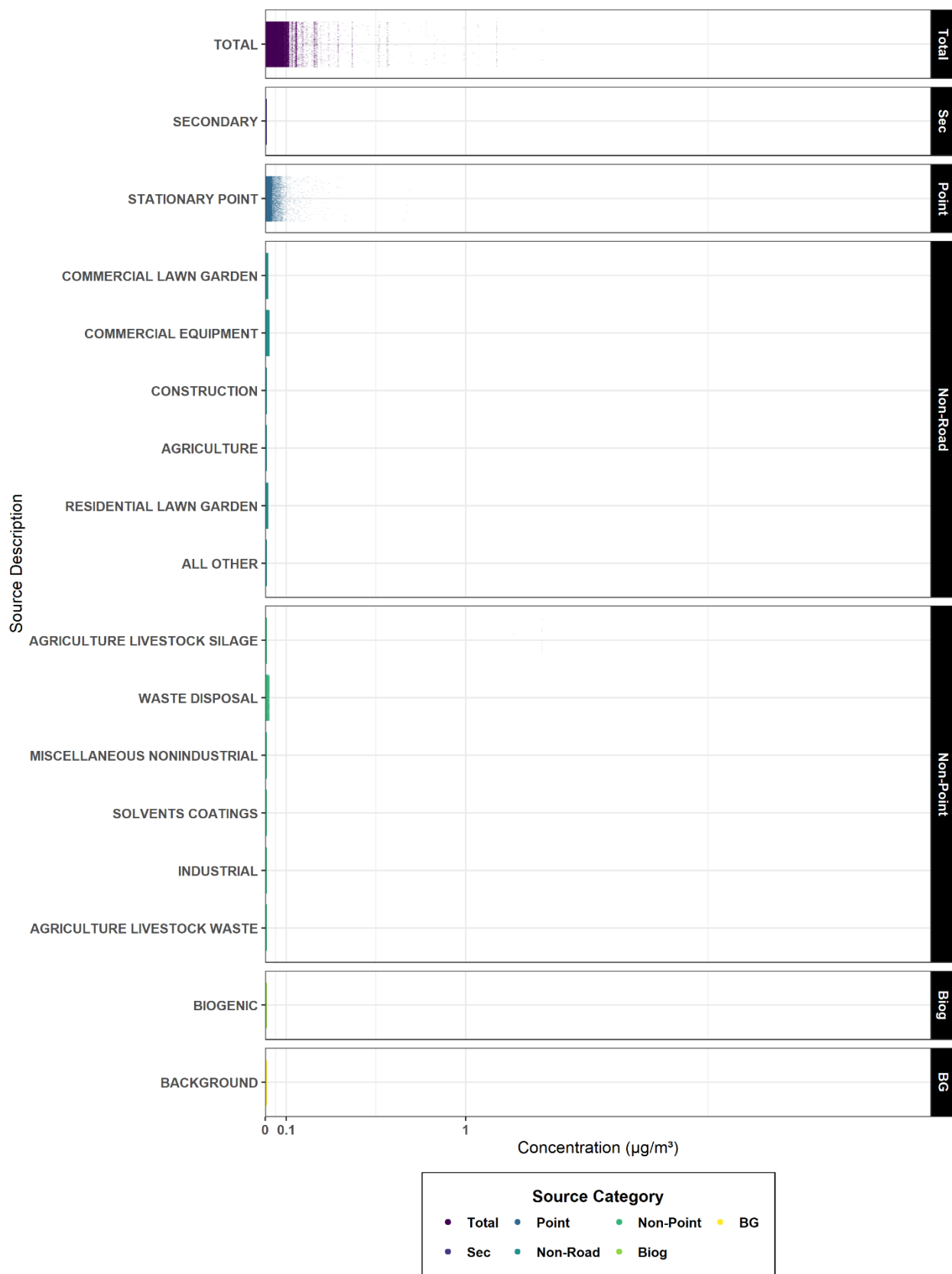


Figure 2-7. 1,3-Butadiene Ambient Air Concentrations Attributable to Non-Fuel and Non-Combustion Sources from AirToxScreen 2020

3 STRENGTHS AND LIMITATIONS, ASSUMPTIONS, UNCERTAINTY, AND CONFIDENCE STATEMENT

3.1 IIOAC

The approach and methodology presented in this ambient air exposure assessment replicates previously peer-reviewed approaches and methods that underwent public comment and incorporates several additional components recommended by peer reviewers and public comments to provide a more comprehensive exposure assessment. As such, EPA has high confidence in the IIOAC modeling used in this assessment to evaluate high-end, conservative, health-protective exposure scenarios to inform whether there are exposures (and associated risk estimates) of concern that warrant more refined analyses or if exposures (and associated risk estimates) of concern are not identified and therefore no further analyses is necessary.

Strengths of this ambient air exposure assessment include use of actual environmental release data from multiple years that are reported by industry, as required by statute, and undergoes repeatable quality assurance quality control reviews ([U.S. EPA, 2025c](#)). These release data are used as direct inputs to two separate EPA peer-reviewed models to estimate concentrations at several distances from releasing facilities where individuals may reside for many years.

Although IIOAC was used as a screening tool, a general limitation of IIOAC is that the modeling is based on pre-run scenarios within AERMOD. As such, default input parameters for IIOAC are confined to those input parameters utilized for those pre-run AERMOD scenarios and cannot be changed, including default stack parameters, 2011 to 2015 meteorological data, and the lack of site-specific information like building dimensions, stack heights, elevation, and land use.

3.2 HEM

The HEM 4.2 Model directly integrates and runs EPA's AERMOD to estimate ambient air concentrations at user-defined distances as well as centroids of census blocks. AERMOD is EPA's regulatory model and has consistently undergone peer review and evaluation as part of the regulatory models process. A description of its promulgation as a regulatory model is included in Appendix W in 40 CFR Part 51. Due to its regular application in assessments to inform regulatory decisions, EPA has high confidence in the modeling results. A limitation of the model is the exclusion of photodegradation processes, which may be relevant to ambient air concentrations of 1,3-butadiene. Although HEM does not consider photodegradation (which may result in conservative concentration estimates), EPA assumes continuous releases and therefore continuous exposure to 1,3-butadiene to the general population. While some photodegradation may occur, a constant release assumes any 1,3-butadiene that may photodegrade is replenished by additional 1,3-butadiene released.

3.3 TRI Release Dataset

There are several assumptions, strengths, limitations, and uncertainties associated with the TRI dataset. One strength of the TRI-reported releases is they are industry reported releases which are required by statute and submitted annually. Additionally, the TRI-reported releases generally capture the highest releasing facilities across the nation due to certain reporting requirements within the statute and applicable regulations. Since TRI releases are reported annually, the 6 years of TRI release data evaluated for 1,3-butadiene provide greater confidence that higher years of release are not missed and maintains a higher level of health protection. This adds confidence the TRI dataset captures the facilities with the greatest impact on ambient concentrations, exposures, and risks and thus is health-protective.

When considering aggregate exposures (or census block estimates) with the TRI dataset, the total facility-reported releases are tied to a specific facility (with a latitude and longitude). This provides strength to the assessment because both the fugitive- and stack-reported releases for an aggregate assessment are spatially aligned. If only the highest release reported for each facility (fugitive and stack) is evaluated, however, while they align spatially (from the same facility), they may not align temporally (if they occur in different years), which would decrease confidence in the exposure scenario, but maintain confidence they are health protective (the highest reported release across all years reported). Another limitation when considering aggregate exposure (and associated risks) with the TRI dataset using HEM is the removal of the TSCA COU specific exposures and risks at each census block. This is an unavoidable outcome when using the HEM aggregate analysis within the TSCA RE context because it considers the impact of each facility releasing the chemical being evaluated in proximity to each census block (which gives a representative aggregate exposure), but all facilities impacting a given census block are rarely associated with the same industry sector/OES/COU. Therefore, while it provides a more representative “aggregate” exposure and risk, it is not possible to tie those aggregate exposures or risks to a single TSCA COU. Finally, another uncertainty when considering aggregate using the TRI dataset is the accuracy and precision of the latitude and longitude reported by a facility. The TRI-reported latitude and longitude is generally a single, possibly centralized location that may not represent the actual release point. This is an uncertainty because for the TRI dataset aggregated concentrations at the centroid of each census block are dependent on the actual distance from a release point and a small shift in the actual location of the release point (latitude/longitude) can change the modeled concentrations at the centroid of each census block.

3.4 NEI Release Dataset

Similar strengths and uncertainties described in the TRI dataset are also associated with the NEI dataset. Unlike TRI-reported releases however, NEI releases may be reported by industry or by States. This introduces an additional step of review, or submittal, which could add some uncertainty because they are not necessarily direct reports from industry. Additionally, sometimes if there is a data gap in the NEI data, either the States or EPA may utilize TRI-reported release information to backfill the NEI dataset. While these are both generally reported releases, when TRI data are used to backfill for NEI data, the process level specificity for which the raw NEI data are reported is lost. Additionally, NEI data are reported on a 3-year cycle and therefore do not have the capability to support annual trend analyses as can be done with TRI data. Furthermore, to align with TRI results (and maintain some comparability), the TSCA REs keep the release years somewhat consistent for the evaluation. In the case of using the NEI dataset, this limits EPA to a single year of NEI-reported releases (*e.g.*, 2017 or 2020) or two reporting cycle years (*e.g.*, 2017 and 2020). Since these data are not annual, there is uncertainty associated with what year the reported releases actually occur (or if the reported release is a three-year average release, etc.). Finally, since the NEI dataset is reported on a 3-year cycle, the final release dataset numbers are not available until several years after the reporting year concludes due to the need to validate and QC the reported numbers. This limits EPA’s ability to use the most recent NEI release numbers under the current 3-year statutory deadlines for TSCA risk evaluations. Even when final numbers are available for a specific NEI reporting year, those data are already several years old and some may argue such releases are not representative of current year operations or releases; nonetheless, it is the best available data at the time of the analysis and can be relied upon for exposure and risk characterization, risk determination, and to support regulatory decision-making.

While NEI often captures more facilities than TRI (due to the absence of reporting thresholds for NEI), the additional facilities in NEI are often smaller facilities that contribute much less to the overall exposure and risk profiles relative to TRI-reported releases. Considering the additional time needed to develop input files and run HEM directly using the NEI dataset, this may be viewed as a limitation to

using NEI data for analysis without the need for an added refinement over an analysis using the TRI dataset. At the same time, some facility releases are reported to NEI but not reported to TRI. This can lead to the NEI dataset capturing substantially more facilities and TSCA COUs that would otherwise be missed if just the TRI dataset was considered. Nonetheless, past experience with NEI datasets has found the additional facility releases captured by NEI are often lower than TRI-reported releases for the majority of facilities and TSCA COUs captured by both datasets as shown in the comparison provided in this TSD. Therefore, although the NEI dataset captures more facilities, the additional analyses often do not change the overall conclusions drawn based on the TRI dataset. An advantage of evaluating both TRI and NEI datasets allows a more direct comparison of exposures (and associated risks) across datasets at the facility level. However, the inconsistencies across facilities and reported releases between TRI and NEI due to different reporting requirements, thresholds, and other factors can significantly limit the added benefits of such a comparison. Finally, similar to the TRI dataset, the precision and accuracy of the NEI-reported latitude and longitude for each process-unit within each facility brings in additional uncertainty in particular when considering impacts of each process unit on an aggregate exposure at the census block level. A slight shift in the actual latitude and longitude of an individual process unit can have a significant impact on the modeled concentration at each centroid of each census block impacted by the process unit.

3.5 AirToxScreen

AirToxScreen has been previously reviewed by EPA's Science Advisory Board (SAB). As such, EPA has confidence in the modeled data. Similarly, these data are based on the NEI, which has been rated as a high-quality data source according to the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances, Version 1.0: A Generic TSCA Systematic Review Protocol with Chemical-Specific Methodologies* (also called the "Draft Systematic Review Protocol") ([U.S. EPA, 2021](#)).

The strengths of these data are that they show the various potential sources of 1,3-butadiene in the coterminous United States. The limitations of these data are that they cannot be directly compared to COUs as they are not representative of facility-scale releases and subsequent ambient air concentrations. A key assumption of AirToxScreen is that it cannot provide a precise exposure and risk for a specific person. Instead, these results are best applied to understand differences in potential sources of 1,3-butadiene.

3.6 AMTIC Dataset

AMTIC archive data are reviewed and verified by the AMTICs Ambient Air Monitoring Group, which has codified various quality assurance steps to ensure data quality and has been certified in accordance with 40 CFR 58.15. EPA has high confidence in the AMTIC archive dataset ([U.S. EPA, 2022](#)), which received a high-quality rating from EPA's systematic review process ([U.S. EPA, 2025a](#)).

The primary limitations of the AMTIC data are that the data have not been annualized and therefore represents a diverse collection of sampling durations (none of which are annual averages) that are not directly comparable to IIOAC-, HEM-, or AirToxScreen-modeled concentrations. Additionally, because monitored data represents a total aggregate concentration from all sources of 1,3-butadiene contributing to ambient air concentrations, the national AMTIC archive dataset is not associated with COUs for purposes of characterizing exposures or risks under TSCA.

3.7 OAR Fenceline Monitoring for Synthetic Organic Chemical Manufacturing Industry (SOCMI) RTR

As part of the risk and technology review process for the Synthetic Organic Chemical Manufacturing Industry: National Emission Standards for Hazardous Air Pollutants – 40 CFR part 63, subparts F, G, H, I (often referred to as the “HON”), EPA’s OAR issued information requests, pursuant to section 114 of the CAA, in June 2021 and July 2022, requiring nine facilities (see Table 2-3) subject to the HON conduct fenceline monitoring for six HAPs, including 1,3-butadiene, to collect the monitoring data, and submit it to EPA. Eight facilities conducted fenceline monitoring samples for 1,3-butadiene, samples were collected on a 14-day sampling period using passive sorbent tubes for three consecutive periods for a total of 42 days between April and July 2022. One facility collected samples from January 2022 to December 2024. These monitoring data were published in [EPA-HQ-OAR-2022-0730-0091](#). While this data can be used to contextualize modeled data, they are not the best available data on which to base the TSCA 1,3-butadiene risk evaluation for the following reasons: the monitoring results cannot be associated with a single COU; OAR monitoring data were measured on facility property and is not representative of census block exposures to the general population; OAR data represent only 9 of 40 TRI facilities categorized under the Manufacturing COU; and they represent a snapshot (42 days), with the exception of 1 facility, of the air concentration and cannot be extrapolated to annual concentrations with confidence.

3.8 Weight of Scientific Evidence

EPA has robust confidence in the overall characterization of exposures in this general population exposure assessment for ambient air. This confidence is based on EPA’s use of methodologies and models that previously underwent peer review and public comment. Additionally, this assessment integrates many recommendations and feedback received by both SACC and the public (including industry and other represented groups). EPA expanded the release datasets considered to include both TRI and NEI datasets that received high quality ratings from EPA’s systematic review process across multiple years for both datasets ([U.S. EPA, 2025a](#)). Results from all datasets provide consistent characterizations of exposures across all datasets and years considered.

Modeled results using both datasets were used to derive exposure concentrations at distances from releasing facilities where individuals reside for many years. The use of release data across multiple years of data provides a comprehensive ambient air exposure assessment and helps ensure higher release years are not missed which provides added confidence to EPA’s use of modeled concentrations to characterize exposures. Furthermore, use of actual reported releases minimizes uncertainties around estimated releases using theoretical distributions and provides added confidence that modeled concentrations and exposures are real and not hypothetical apart from EPA estimated releases for the Adhesives and sealants OES.

Furthermore, EPA used additional lines of evidence including AirToxScreen, monitoring data from the AMTIC archive, fenceline monitoring data, modeling information in OAR’s SOCMI RTR obtained in coordination with EPA’s OAR, and information in literature provided by SACC to contextualize and compare measured ambient air concentrations of 1,3-butadiene to ground truth EPA’s modeled concentrations. These additional lines of evidence further provided characterizations of exposures consistent with those based on the modeled concentrations. In particular, when EPA modeled concentrations are compared to monitoring data (AMTIC and OAR data), the modeled concentrations generally are within the same order of magnitude and less than monitored concentrations. This is further supported through the findings of ([Padilla et al., 2024](#)) that found nationwide comparisons of measured concentrations of 79 HAPS (including 1,3-butadiene) were higher than modeled concentrations in 74

percent of comparisons over all monitors, chemicals, and years assessed. This finding supports EPA's modeling estimates do not overestimate ambient concentrations of 1,3-butadiene, which further strengthens EPA's reliance on modeled concentrations to derive risk estimates and inform risk determinations and rulemaking for 1,3-butadiene. Padilla and colleagues also conclude "as long as ambient air monitoring remains sparse, the exposure models that we evaluated and similar modeling systems are the best available tools for large-scale screening level risk assessments"—providing added support to EPA's used of modeled concentrations to derive risk estimates. OAR's modeled concentrations for the SOCMR RTR and fence-line monitoring data provided in [EPA-HQ-OAR-2022-0730-0091](#) provide additional support and consistency with OPPT's characterization of 1,3-butadiene exposures, further strengthening confidence in OPPT's characterization of exposures and deriving risk estimates based on modeling performed in this assessment. This confidence statement is consistent with the Draft Systematic Review Protocol ([U.S. EPA, 2021](#)).

Taken together, the various modeling and monitoring lines of evidence considered by EPA in this general population exposure assessment for 1,3-butadiene give the Agency robust confidence in its characterization of exposures. Additionally, the various lines of evidence support EPA's use of the modeled concentrations in this assessment to derive risk estimates and inform risk determination and rulemaking for 1,3-butadiene. Lastly, the various lines of evidence described above demonstrate the OPPT methodologies and models used for this 1,3-butadiene assessment do not overestimate exposures of the general population to 1,3-butadiene via the ambient air pathway.

4 CONCLUSIONS

To evaluate general population exposure and risks to 1,3-butadiene, EPA utilized a three-tiered approach and modeled ambient air concentrations using both the IIOAC and HEM Models to assess general population exposures to 1,3-butadiene based on TRI and NEI release data.

In the Tier I analysis, IIOAC modeling with TRI release data resulted in no expectation of non-cancer risks but warranted refined analysis for cancer risk estimates. In the Tier II analysis, HEM modeling with TRI release data resulted in no expectation of aggregate non-cancer risks but warranted refined analysis for cancer risk estimates using HEM modeling with NEI release data that is provided in detail in the *Risk Evaluation for 1,3-Butadiene* ([U.S. EPA, 2025h](#)).

In addition, EPA used monitoring data from the AMTIC archive ([U.S. EPA, 2022](#)) as well as information obtained from EPA's OAR (for a limited number of facilities) to ground-truth results from the models and to reflect aggregate 1,3-butadiene ambient air concentrations from all sources. To contextualize and characterize other sources of 1,3-butadiene, EPA also evaluated data from the 2020 AirToxScreen to show how different source categories contribute to total ambient air concentrations of 1,3-butadiene nationwide.

The 95th percentile-modeled results from IIOAC for exposure concentrations to populations living near industrial facilities (within 100–1,000 m [6.2×10^{-2} to 0.62 miles]) releasing 1,3-butadiene to the ambient air ranged from 0.0 to 110 $\mu\text{g}/\text{m}^3$ when using TRI release data as inputs. Results from refined modeling using HEM v4.2 ranged from 0.0 to 91 $\mu\text{g}/\text{m}^3$ when using TRI release data as inputs for populations living 100 to 1,000 m (6.2×10^{-2} to 0.62 miles). For all distances modeled with HEM 10 to 50,000 m (6.0×10^{-3} to 31 miles), the concentration range was 0.0 to 383 $\mu\text{g}/\text{m}^3$, with the highest concentrations within the first 30 to 60 m away from the release point based on TRI releases. For all distances modeled with HEM 10 to 50,000 m (6.0×10^{-3} to 31 miles), the concentration range was 0.0 to 386 $\mu\text{g}/\text{m}^3$, with the highest concentrations within the first 60 to 100 m away from the release points based on NEI releases. Detected 1,3-butadiene monitoring concentrations extracted from AMTIC archive (2016–2022) ranged from 2.0×10^{-3} to 267 $\mu\text{g}/\text{m}^3$ across all monitored 24-hour sampling values and from 4.0×10^{-3} to 3,045 $\mu\text{g}/\text{m}^3$ across all monitored 1-hour sampling values. Both 24- and 1-hour sampling values indicated a positive skewness in the distribution of monitored data with roughly 95 percent of the detected concentrations reported as below 1 $\mu\text{g}/\text{m}^3$. The OAR AirToxScreen 2020 Assessment based on NEI 2020 data, modeled a range of 3.8×10^{-7} to 4.1 $\mu\text{g}/\text{m}^3$ across all 10 EPA regions. AirToxScreen modeled 1,3-butadiene concentrations are attributable to 38 source categories that includes point sources, nonpoint sources, combustion sources, and onroad/nonroad sources.

Although not directly comparable, taken together, these results show that modeled 1,3-butadiene ambient air concentrations using IIOAC and HEM were less than the monitoring data from the AMTIC archive and the OAR monitoring data obtained for the SOCMIRTR and in the same order of magnitude. This aligns as expected when characterizing exposures associated with COUs, for purposes of informing regulatory decisions under TSCA, because modeled concentrations contribute to a part of the total concentrations captured by monitoring stations but are independent and exclusive contributors relative to other sources like mobile onroad and off-road sources. More specifically, modeled concentrations presented in this ambient air assessment of 1,3-butadiene are representative of exposures from COUs alone and are additive to other sources when determining a total concentration at a given location. Total exposure to 1,3-butadiene captured by monitoring stations at a given location is representative of all concentrations from all contributing sources (*e.g.*, COUs, onroad and off-road sources). Therefore, to determine a total exposure at a given location, an assessor can add the contribution of 1,3-butadiene from COUs to the contribution of 1,3-butadiene from other sources contributing 1,3-butadiene to the

ambient air at the given location. While it is often recommended that EPA's TSCA risk evaluations should consider "total exposure" to 1,3-butadiene via the ambient air pathway (resulting from every source [COUs and other sources]), it does not provide added benefit for regulatory decision-making under TSCA for this assessment of 1,3-butadiene because the statutory requirements of TSCA provide authority to regulate exposures (and associated risks) resulting from COUs but not other sources not attributable to COUs.

The following COUs/OESs resulted in the highest 1,3-butadiene concentrations based on the HEM modeling with NEI data conducted for this assessment:

- Manufacturing
 - Import
- Processing
 - Processing as a reactant
 - Processing, incorporation into formulation, mixture, or reaction product

Although EPA has monitoring data from both the AMTIC archive and OAR information requests and uses this monitoring data to ground truth modeled concentrations, the monitoring results cannot be associated with a single COU. Therefore, EPA relied upon the modeled concentrations from HEM using NEI data for purposes of deriving risk estimates, risk determination, and regulatory decision-making.

EPA has robust confidence in the overall characterizations for this general population exposure and risk assessment. Exposure results relied upon peer-reviewed models and industry-reported releases as direct inputs to those models, which can be tied to COUs to derive exposure concentrations at distances from releasing facilities where those within the general population typically reside or frequent for many years. The alignment between monitoring data (across both AMTIC archive and OAR data) and the modeled concentrations shows both modeled and monitoring data are within the same magnitude and that the modeled concentrations are lower than the highest monitored concentrations. This provides added strength and confidence to EPA's use of modeled results to characterize human exposures to 1,3-butadiene via the ambient air pathway since modeled concentrations are COU-specific and representative of expected exposures when compared to monitored data (both AMTIC archive and OAR data).

5 REFERENCES

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APPENDICES

Appendix A INTEGRATED INDOOR/OUTDOOR AIR CALCULATOR MODEL

A.1 IIOAC Modeling

IIOAC is a spreadsheet-based tool that estimates indoor and outdoor ambient air concentrations at three distances from sources that release chemical substances to the air. IIOAC uses pre-run results from a suite of dispersion scenarios modeled with AERMOD. While the pre-run scenarios include a variety of meteorological and land-use settings, the IIOAC Model is still limited by the parameterizations utilized for those pre-run scenarios (meteorologic data, stack heights, distances, exposed population, etc.). Additional information on IIOAC can be found in the user guide ([U.S. EPA, 2019](#)).

As stated in Section 1, EPA applied a three-tiered approach to assessing general population exposures to 1,3-butadiene via the ambient air pathway. The tiered approach and results are summarized in Section 5.3.4 of the *Risk Evaluation for 1,3-Butadiene* ([U.S. EPA, 2025h](#)), with each tier described in more detail below. For the first tier analysis, EPA used the IIOAC Model to estimate daily-averaged and annual-averaged 1,3-butadiene ambient air concentrations at three predefined distances (100, 100–1,000, and 1,000 m) from facilities reporting 1,3-butadiene air releases to the TRI for one or more of the reporting years evaluated (2016–2021). IIOAC Model results are used to evaluate potential exposures for the general population living near industrial facilities reporting releases of 1,3-butadiene to the ambient air. For this assessment, IIOAC was used for a screening analysis to identify facilities/COUs which may raise exposure concerns and inform whether higher-tier analysis and/or refined modeling is warranted to further characterize exposures of the general population to 1,3-butadiene. Complete results of IIOAC modeling are provided in the supplemental file *Integrated Indoor Outdoor Air Calculator (IIOAC) TRI 2016–2021 Exposure and Risk Analysis for 1,3-Butadiene* ([U.S. EPA, 2025f](#)).

A.1.1 Exposure Scenarios

IIOAC can model a variety of user defined input parameters and exposure scenarios, including varying release scenarios/patterns, release types, release durations, urban/rural settings (topography), and meteorological conditions. Releases from individual facilities reported in TRI 2016 to 2021 were reported as stack and/or fugitive releases; with facilities reporting both types of releases. Stack and fugitive releases reported to TRI were used as direct inputs to IIOAC and were modeled separately (stack releases as point sources, fugitive releases as area sources). Modeled concentration outputs from IIOAC for each release type are then summed together by facility and year to give a “total” exposure from both release types at each distance evaluated for each facility. EPA modeled stack and fugitive releases using the default parameters integrated within the IIOAC Model, along with a user-defined length and width for fugitive releases shown in Table_Apx A-2.

Table_Apx A-1. IIOAC Default Input Parameters for Stack and Fugitive Air Releases

Stack Release Parameters	Value	Fugitive Release Parameters	Value
Stack height (m)	10	Length (m)	10
Stack diameter (m)	2	Width (m)	10
Exit velocity (m/sec)	5	Angle (°)	0
Exit temperature (K)	300	Release height (m)	3.05

For this general population exposure assessment, modeled air concentrations from IIOAC are based on the following:

1. The annual release values reported by individual facilities (assigned to OESs and mapped to respective COUs for the TRI 2016–2021 datasets), assuming the total annual reported releases are continuous and equally distributed across all days of operation.
2. An operating scenario representing industrial facilities releasing 1,3-butadiene to the ambient air operating 24 hours/day, 7 days/week, 365 days/year. This is a conservative assumption for this screening level estimate, in which, facilities are constantly releasing 1,3-butadiene every hour of every day throughout the year.
3. Application of the meteorology patterns from the Lake Charles, Louisiana (south coastal), meteorological station to every facility (regardless of the facility's geographic location), and assumption of a "rural" land designation for every facility. These assumptions result in conservative air concentration results appropriate for a screening level model. This designation of meteorology and land designation is recommended in the IIOAC User Guide ([U.S. EPA, 2019](#)) for use when conservative estimates are desired.

A.1.2 IIOAC Model Output

The IIOAC model provides output values for daily-average and annual-average high-end (95th percentile) and mean (50th percentile) ambient air concentrations in circular rings at two finite distances (100 and 1,000 m) and one area distance (between 100–1,000 m) from releasing facilities. These distances are also referred to as "fenceline," "outer-boundary," and "community average," respectively, in IIOAC. The daily-average values are obtained by adding all modeled hourly concentrations for each day evaluated. The annual average is a 365 day rolling average of each daily average value across the 5 years of meteorological data modeled in IIOAC. Since IIOAC was modeled based on facilities releasing 1,3-butadiene to the ambient air with a steady, continuous release over time, operating 24 hours/day, 7 days/week, 365 days/year, the daily-average and annual-average concentrations are equal.

For the two finite distances (100 and 1,000 m), IIOAC considers a polar grid of 16 modeled exposure receptors evenly spaced around each distance ring. Since EPA considered 6 years of environmental release data (TRI 2016–2021) for this assessment and the exposure scenario assumes 365 days of operation each year (366 for a leap year), this results in a total of 2,192 separate daily-averaged concentrations for each receptor around each finite distance ring. For the area distance (between 100–1,000 m from the releasing facility), IIOAC uses a cartesian grid of 228 receptors and 234 receptors, for stack and fugitive releases, respectively, placed at 100-meter intervals across the entire area. The daily and annual averages for the area distance are calculated across all receptors within the area distance and therefore represents an average concentration within the area distance rather than at each receptor within the area distance.

The 95th percentile concentration at each distance ring (100, 100–1,000, and 1,000 m) is the 95th percentile-modeled concentration across the entire distribution of modeled concentrations at each distance per facility per TRI reporting year. Generally, for the finite distances, the 95th percentile represents a downwind concentration at a modeled exposure point where a resident lives downwind of the industrial release, considering a non-site-specific estimate for dispersion and dilution. Additional information on IIOAC outputs can be found in the user guide ([U.S. EPA, 2019](#)).

The 95th percentile results for ambient modeled concentrations across all facilities, reporting years and modeled distances (100, 100–1,000 and 1,000 m) ranged from 0 to 110 $\mu\text{g}/\text{m}^3$ with the highest modeled

concentrations at 100 m). Mean-modeled concentration results are shown in Table_Apx A-4. For full IIOAC modeling results, see the supplemental file: *Integrated Indoor Outdoor Air Calculator (IIOAC) TRI 2016–2021 Exposure and Risk Analysis for 1,3-Butadiene* ([U.S. EPA, 2025f](#)).

A.1.3 IIOAC Screening Assessment Results

A total of 225 TRI reporting facilities reported releases of 1,3-butadiene to the ambient air. The following three OESs had the highest modeled 95th percentile concentrations relative to the other calculated exposure concentrations evaluated:

- Plastics and rubber polymerization (110 µg/m³);
- Manufacturing (80 µg/m³) and;
- Processing as a reactant (41 µg/m³).

IIOAC-modeled exposure concentrations results were used to calculate non-cancer and cancer risks in the following section as a screening tool to determine whether refined analyses and higher-tier modeling were warranted.

A.1.4 Risk Calculations

A.1.4.1 Inhalation Margin of Exposure

EPA used an MOE approach using high-end exposure estimates to determine if the pathway analyzed is a pathway of concern. The MOE is the ratio of the non-cancer hazard value (or point of departure [POD]) divided by a human exposure concentration. The chronic MOEs for non-cancer inhalation risks were calculated using Equation_Apx A-1 below.

Equation_Apx A-1. Margin of Exposure Calculation

$$MOE = \frac{\text{Non-Cancer Hazard Value (POD)}}{\text{Human Exposure}}$$

Where:

<i>MOE</i>	=	Margin of exposure for acute, short-term, or chronic risk comparison (unitless)
<i>Non-Cancer Hazard Value (POD)</i>	=	HEC (µg/m ³)
<i>Human Exposure</i>	=	Exposure estimate (µg/m ³)

MOE risk estimates may be interpreted in relation to benchmark MOEs. Benchmark MOEs are typically the total uncertainty factor for each non-cancer POD. The MOE estimate is interpreted as a human health risk of concern if the MOE estimate is less than the benchmark MOE (*i.e.*, the total uncertainty factor). On the other hand, for this screening level analysis, if the MOE estimate is equal to or exceeds the benchmark MOE, the exposure pathway is not analyzed further. Typically, the larger the MOE, the more unlikely it is that a non-cancer adverse effect occurs relative to the benchmark. When determining whether a chemical substance presents unreasonable risk to human health or the environment, calculated risk estimates are not “bright-line” indicators of unreasonable risk, and EPA has the discretion to consider other risk-related factors in addition to risks identified in the risk characterization.

In brief, after considering hazard identification and evidence integration, dose-response evaluation, and weight of scientific evidence of POD candidates, EPA chose one non-cancer endpoint for general population chronic exposure with an HEC value of 2.5 ppm (5,500 µg/m³) and a benchmark of 30. For more details on the non-cancer hazard values used to screen for risk, see the *Human Health Hazard*

Assessment for 1,3-Butadiene ([U.S. EPA, 2025e](#)). No calculated MOE risk estimate was below the benchmark of 30 for any TRI-reported release modeled with IIOAC at the 100, 100 to 1000, and 1000 m distances.

A.1.4.2 Inhalation Cancer Risk

Lifetime cancer risk is calculated with Equation_Apx A-2 using the lifetime average daily concentration (LADC) based on the 95th percentile-modeled annual air concentration and the general population IUR of 5.8×10^{-6} per $\mu\text{g}/\text{m}^3$ from the *Human Health Hazard Assessment for 1,3-Butadiene* ([U.S. EPA, 2025e](#)):

Equation_Apx A-2. Lifetime Cancer Risk Calculation

$$\text{Lifetime Cancer Risk} = \text{LADC} \times \text{IUR}$$

$$\text{Lifetime Cancer Risk} = \text{LADC} \left(\frac{\mu\text{g}}{\text{m}^3} \right) \times \frac{5.8E^{-6}}{\mu\text{g}/\text{m}^3}$$

Where:

LADC = Lifetime average daily concentration
IUR = Inhalation unit risk (risk per unit of exposure ($\mu\text{g}/\text{m}^3$))

If the calculated lifetime cancer risk is above the cancer risk benchmark of 1 in a million (or 1×10^{-6}), then risk is potentially identified and warrants further evaluation.

A.1.5 Screening Level Risk Estimates

For this assessment, because of assumptions made for general population analysis regarding exposure duration, exposure frequency, breathing rates, and other factors that are used to calculate exposure concentrations from modeled air concentrations, an individual's exposure concentration is equivalent to the modeled ambient, outdoor concentration from the IIOAC outputs. Therefore, the annual-average-modeled ambient air concentration results from IIOAC are equal to the chronic exposure concentrations used to calculate chronic non-cancer and cancer screening level risk estimates.

Because EPA used the IIOAC-modeled results as a screening level analysis to assess if one or more facilities/COUs may raise exposure (and associated risk) concerns for 1,3-butadiene, the Agency also used the IIOAC screening level results to derive screening level chronic non-cancer and cancer risk estimates. The screening level risk estimates were used to inform whether higher-tier/more refined exposure analyses were warranted. Exposure concentrations, chronic non-cancer, and cancer screening level risk estimates based on IIOAC-modeled results are presented and summarized in Appendix A. Hazard values used to calculate screening level risk estimates are described in the *Human Health Risk Assessment for 1,3-Butadiene* ([U.S. EPA, 2025e](#)). MOEs were calculated at each distance (100, 100–1,000, and 1,000 m) using the 95th percentile IIOAC-modeled ambient air concentrations as conservative exposure estimates for each individual facility and for every reporting year. As further described in Section 5.3.4 of the *Risk Evaluation for 1,3-Butadiene* ([U.S. EPA, 2025h](#)), all non-cancer screening level risk estimates exceeded the chronic non-cancer benchmark; therefore, there is no expectation of non-cancer risks to the general population from TRI facility releases based on this screening level assessment.

Multiple screening level cancer risk estimates calculated using the 95th percentile and mean concentrations from the IIOAC-modeled outputs were at or above 1 in a million—including several at

the 1,000-meter finite distance from a releasing facility. Table_Apx A-2 summarizes the 95th percentile IIOAC-modeled concentrations at each distance and number of facilities in each OES, whereas Table_Apx A-3 summarizes the calculated risks at each distance and number of facilities in each OES that resulted in cancer risk estimates at or above 1 in a million based on the 95th percentile IIOAC-modeled concentrations. Lifetime cancer risk across all three distances evaluated ranged from 0 to 6.4×10^{-4} . Out of the 225 TRI facilities, a total of 135 modeled concentrations (Table_Apx A-4) resulted in cancer risk estimates at or above 1 in a million based on mean IIOAC-modeled concentrations (Table_Apx A-5). Because the screening level risk estimates derived using IIOAC results were at or exceeded 1 in a million, EPA conducted a second tier analysis using HEM, which entailed a more geographically-refined analysis of ambient air concentrations using localized meteorological data and site-specific parameters (when available).

Table_Apx A-2. IIOAC 95th Percentile Modeled Concentrations ($\mu\text{g}/\text{m}^3$)

IIOAC 95th Percentile Modeled Concentrations ($\mu\text{g}/\text{m}^3$)			Distance		
OES	TRI Facility Count	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
Manufacturing	40	Max	80	11	5.3
		Mean	8.7	1.2	0.50
		Median	2.1	0.30	0.14
		Min	0	0	0
Plastics and rubber polymerization	33	Max	110	13	5.2
		Mean	9.4	1.2	0.48
		Median	3.2	0.41	0.17
		Min	3.0E–04	9.4E–05	5.0E–05
Plastics and rubber compounding converting	1	Max	3.5E–07	1.1E–07	5.8E–08
		Mean	3.5E–07	1.1E–07	5.8E–08
		Median	3.5E–07	1.1E–07	5.8E–08
		Min	3.5E–07	1.1E–07	5.8E–08
Processing – incorporation into formulation, mixture, or reaction product	53	Max	10	3.1	1.6
		Mean	0.60	9.0E–02	4.0E–02
		Median	5.4E–02	9.6E–03	4.6E–03
		Min	0	0	0
Processing as a reactant	57	Max	41	4.9	2.0
		Mean	2.1	0.26	0.11
		Median	0.34	4.5E–02	1.9E–02
		Min	0	0	0
Recycling	11	Max	1.2	0.14	5.5E–02
		Mean	0.20	2.6E–02	1.1E–02
		Median	0.11	1.5E–02	6.8E–03
		Min	2.2E–04	7.1E–05	3.8E–05
Repackaging	23	Max	20	2.5	1.0
		Mean	1.4	0.17	6.9E–02
		Median	5.8E–02	6.8E–03	2.7E–03

HIOAC 95th Percentile Modeled Concentrations ($\mu\text{g}/\text{m}^3$)			Distance		
OES	TRI Facility Count	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
		Min	0	0	0
Waste handling, disposal, treatment, and recycling	7	Max	0.25	2.9E–02	1.2E–02
		Mean	1.9E–02	3.2E–03	1.5E–03
		Median	8.8E–04	1.4E–04	6.5E–05
		Min	2.3E–05	3.0E–06	1.3E–06
Total	225				

Table_Apx A-3. Cancer Risk Estimates Based on HIOAC 95th Percentile-Modeled Concentrations

Cancer Risk Estimates Based on HIOAC 95th Percentile Modeled Concentrations				Distance		
OES	TRI Facility Count	Number of Facilities Above 1E–06	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
Manufacturing	40	31	Max	4.7E–04	6.7E–05	3.1E–05
			Mean	5.1E–05	6.9E–06	3.0E–06
			Median	1.2E–05	1.8E–06	8.2E–07
			Min	0	0	0
Plastics and rubber polymerization	33	30	Max	6.4E–04	7.6E–05	3.1E–05
			Mean	5.5E–05	6.8E–06	2.8E–06
			Median	1.9E–05	2.4E–06	1.0E–06
			Min	1.7E–09	5.5E–10	2.9E–10
Plastics and rubber compounding and converting	1	0	Max	2.0E–12	6.5E–13	3.4E–13
			Mean	2.0E–12	6.5E–13	3.4E–13
			Median	2.0E–12	6.5E–13	3.4E–13
			Min	2.0E–12	6.5E–13	3.4E–13
Processing – Incorporation into formulation, mixture, or reaction product	53	25	Max	5.8E–05	1.8E–05	9.7E–06
			Mean	3.5E–06	5.3E–07	2.4E–07
			Median	3.2E–07	5.6E–08	2.7E–08
			Min	0	0	0
Processing as a Reactant	57	36	Max	2.4E–04	2.9E–05	1.2E–05
			Mean	1.2E–05	1.5E–06	6.4E–07

Cancer Risk Estimates Based on IIOAC 95th Percentile Modeled Concentrations				Distance		
OES	TRI Facility Count	Number of Facilities Above 1E-06	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
Recycling	11	4	Median	2.0E-06	2.7E-07	1.1E-07
			Min	0	0	0
			Max	6.8E-06	8.0E-07	3.2E-07
			Mean	1.2E-06	1.5E-07	6.4E-08
			Median	6.4E-07	8.6E-08	4.0E-08
Repackaging	23	8	Min	1.3E-09	4.2E-10	2.2E-10
			Max	1.2E-04	1.4E-05	6.0E-06
			Mean	8.2E-06	9.9E-07	4.1E-07
			Median	3.4E-07	4.0E-08	1.6E-08
Waste handling, disposal, treatment, and recycling	7	1	Min	0	0	0
			Max	1.5E-06	1.7E-07	6.8E-08
			Mean	1.1E-07	1.9E-08	8.6E-09
			Median	5.2E-09	8.3E-10	3.8E-10
Total	225	135				

Table_Apx A-4. IIOAC Mean Modeled Concentrations (µg/m³)

IIOAC Mean Modeled Concentrations (µg/m ³)			Distance		
OES	TRI Facility Count	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
Manufacturing	40	Max	73	10	4.5
		Mean	8.0	1.0	0.43
		Median	1.9	0.27	0.12
		Min	0	0	0
Plastics and rubber polymerization	33	Max	100	11	4.4
		Mean	8.6	1.0	0.41
		Median	2.9	0.36	0.14
		Min	2.6E-04	8.2E-05	4.3E-05
Plastics and rubber compounding and converting	1	Max	3.0E-07	9.7E-08	5.1E-08

IIOAC Mean Modeled Concentrations ($\mu\text{g}/\text{m}^3$)			Distance		
OES	TRI Facility Count	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
		Mean	3.0E-07	9.7E-08	5.1E-08
		Median	3.0E-07	9.7E-08	5.1E-08
		Min	3.0E-07	9.7E-08	5.1E-08
Processing – incorporation into formulation, mixture, or reaction product	53	Max	8.6	2.7	1.4
		Mean	0.55	8.0E-02	3.4E-02
		Median	4.9E-02	8.4E-03	3.9E-03
		Min	0	0	0
Processing as a reactant	57	Max	38	4.3	1.7
		Mean	1.9	0.23	9.2E-02
		Median	0.31	4.0E-02	1.6E-02
		Min	0	0	0
Recycling	11	Max	1.1	0.12	4.6E-02
		Mean	0.18	2.3E-02	9.3E-03
		Median	9.8E-02	1.3E-02	5.7E-03
		Min	2.0E-04	6.2E-05	3.3E-05
Repackaging	23	Max	18	2.2	0.85
		Mean	1.3	0.15	5.8E-02
		Median	5.3E-02	6.0E-03	2.3E-03
		Min	0	0	0
Waste handling, disposal, treatment, and recycling	7	Max	0.23	2.6E-02	9.7E-03
		Mean	1.7E-02	2.8E-03	1.3E-03
		Median	8.0E-04	1.2E-04	5.6E-05
		Min	2.1E-05	2.7E-06	1.1E-06
Total	225				

Table_Apx A-5. Cancer Risk Estimates Based on IIOAC Mean Percentile-Modeled Concentrations

Cancer Risk Estimates Based on IIOAC Mean Modeled Concentrations				Distance		
OES	TRI Facility Count	Number of Facilities Above 1E-06	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
Manufacturing	40	31	Max	4.3E-04	5.9E-05	2.6E-05
			Mean	4.7E-05	6.1E-06	2.5E-06
			Median	1.1E-05	1.6E-06	7.0E-07
			Min	0	0	0
Plastics and rubber polymerization	33	30	Max	5.9E-04	6.8E-05	2.6E-05
			Mean	5.1E-05	6.1E-06	2.4E-06
			Median	1.7E-05	2.1E-06	8.4E-07
			Min	1.5E-09	4.8E-10	2.5E-10
Plastics and rubber compounding and converting	1	0	Max	1.8E-12	5.7E-13	3.0E-13
			Mean	1.8E-12	5.7E-13	3.0E-13
			Median	1.8E-12	5.7E-13	3.0E-13
			Min	1.8E-12	5.7E-13	3.0E-13
Processing – incorporation into formulation, mixture, or reaction product	53	25	Max	5.0E-05	1.6E-05	8.3E-06
			Mean	3.2E-06	4.7E-07	2.0E-07
			Median	2.9E-07	5.0E-08	2.3E-08
			Min	0	0	0
Processing as a reactant	57	36	Max	2.2E-04	2.5E-05	9.8E-06
			Mean	1.1E-05	1.4E-06	5.4E-07
			Median	1.8E-06	2.4E-07	9.4E-08
			Min	0	0	0
Recycling	11	4	Max	6.3E-06	7.1E-07	2.7E-07
			Mean	1.1E-06	1.4E-07	5.4E-08
			Median	5.7E-07	7.6E-08	3.4E-08
			Min	1.2E-09	3.7E-10	1.9E-10
Repackaging	23	8	Max	1.1E-04	1.3E-05	5.0E-06
			Mean	7.5E-06	8.8E-07	3.4E-07
			Median	3.1E-07	3.5E-08	1.3E-08

Cancer Risk Estimates Based on IIOAC Mean Modeled Concentrations				Distance		
OES	TRI Facility Count	Number of Facilities Above 1E-06	Statistic	Fenceline (100 m)	Community (100–1,000 m)	Outer-Boundary (1,000 m)
			Min	0	0	0
Waste handling, disposal, treatment, and recycling	7	1	Max	1.3E-06	1.5E-07	5.7E-08
			Mean	1.0E-07	1.6E-08	7.4E-09
			Median	4.7E-09	7.3E-10	3.3E-10
			Min	1.2E-10	1.6E-11	6.4E-12
Total	225	135				

Appendix B HUMAN EXPOSURE MODEL

B.1 HEM Modeling

EPA used [HEM 4.2](#) (accessed November 21, 2025) to model geographically refined 1,3-butadiene concentrations surrounding releasing facilities. HEM 4.2 has two components: (1) an atmospheric dispersion model, AERMOD, with included regional meteorological data; and (2) U.S. Census Bureau population data at the census block level. The current HEM version utilizes 2020 Census data. AERMOD estimates the magnitude and distribution of chemical concentrations in ambient air in the vicinity of each releasing facility within user-defined radial distances out to 50 km (~30 miles). HEM can also provide risk estimates based on modeled chemical concentrations in ambient air at the centroid of over 8 million census blocks across the United States. The model estimates and aggregates non-cancer and cancer risks at census blocks using ambient concentration estimates from the built-in AERMOD modeling combined with user provided hazard data. HEM automatically utilizes regional meteorological data for each release point, as well as local topographic information, to inform the release dispersion model. In summary, modeling with HEM in this assessment included the following refinements:

1. Modeling of 1,3-butadiene ambient air concentrations at a greater range of radial distances (from 10–50,000 m) from facilities releasing 1,3-butadiene to ambient air.
2. Utilization of over 840 local meteorological station data matched to the release facility's location based on latitude and longitude coordinates (compared to the 14 regional meteorological stations included in the IIOAC Model).
3. Utilization of local topographic information based on actual population data around each release point.
4. Consideration of site-specific emission variations based on facility operating days and hours were used, when available

Refer to the [HEM v4.2 User Guide](#) (accessed November 21, 2025) for more details about these and other capabilities.

B.1.1 Exposure Scenario

EPA evaluated site-specific releases from 225 TRI facilities directly reporting to TRI with Form R using HEM v4.2. The Agency used the same set of default parameters integrated into the IIOAC Model (Table_Apx B-4) in the HEM v4.2 modeling.

Table_Apx B-1. HEM Input Parameters for Stack and Fugitive Air Releases

Stack Release Parameters	Value	Fugitive Release Parameters	Value
Stack height (m)	10	Length (m)	10
Stack diameter (m)	2	Width (m)	10
Exit velocity (m/sec)	5	Angle (degrees)	0
Exit temperature (°K)	300	Release height (m)	3.05

For the exposure scenario modeled with HEM, EPA assumed facilities operated 24 hours/day. For days of operation, EPA used site-specific operating days reported to TRI by facility, which varied from 250 to 350 days a year. Depending on the number of operating days, EPA included an emissions variability component to the HEM input files to ensure the total annual release reported to TRI was captured for modeling less than 365 days per year.

The HEM v4.2 modeling also refined the radial distances evaluated to include 11 finite distances (10-, 30-, 60-, and 100-meter; and 1-, 2.5-, 5-, 10-, 15-, 25-, and 50-kilometer) from the facility center. For these finite distances, 16 exposed receptors were placed in a polar grid around each radial ring every 22.5 degrees (mirroring the polar grid used in IIOAC). In addition, HEM was manually configured to output ambient air concentrations for two area distances (30–60 m and 100–1,000 m).

Industry-reported, total annual, facility-specific releases reported to TRI were used as direct inputs to HEM. EPA set HEM outputs from this analysis to include the 95th percentile annual-average ambient concentrations at each modeled distance ring. These results are then used to characterize exposures farther from facilities than provided by IIOAC and show the impact of distance on 1,3-butadiene exposures. At select distances captured by both IIOAC and HEM analyses, EPA considers the relative contributions from fugitive and stack releases from each facility to help inform risk management and regulatory decision-making for 1,3-butadiene.

To obtain refined cancer risk estimates, the option to apply HEM at the census block level was implemented. Annual, facility-specific TRI releases were used as inputs to HEM, along with IUR values for 1,3-butadiene from the *Human Health Risk Assessment for 1,3-Butadiene* ([U.S. EPA, 2025e](#)). HEM explicitly models concentrations at census blocks near facilities (typically 3 km) and interpolates concentrations at census blocks farther away (out to 50 km). Details on how HEM interpolates from ambient concentrations at ring receptors to obtain concentrations at census block centroids can be found in the [HEM v4.2 User Guide](#) (accessed November 21, 2025). Outputs of this model application include cancer risks at each census block surrounding a facility, together with U.S. Census population counts corresponding to the census block.

See Appendix B.1.4 for details on HEM inputs for TRI releases.

B.1.2 HEM Modeling Results by Radial Distances

Releases from individual facilities reported in TRI 2016 to 2021 were reported as stack and/or fugitive releases, with some facilities reporting both types of releases. Stack and fugitive releases were modeled separately and then aggregated together for facilities that reported both in the same TRI reporting year. This resulted in over 2,200 release scenarios modeled through HEM (225 TRI facilities with stack and/or fugitive source emissions across 6 reporting years). The 95th percentile concentrations at each distance ring modeled by HEM were grouped together based on the facility's assigned OESs and associated COUs and summarized across the distances 10 to 50,000 m from facility release points.

Ninety-fifth percentile-modeled ambient air concentrations from HEM across all TRI facility releases and all distances (10–50,000 m) reporting from 2016 to 2021 ranged from 0.0 to 383.4 $\mu\text{g}/\text{m}^3$, with the greatest concentrations modeled within the first 60 m from industrial facilities. To simplify presentation of results, EPA focused on modeled air concentrations at distances of 100, 100 to 1,000, and 1,000 m. These distances are also consistent with the community populations living near facilities as described in the fenceline methodology ([Draft Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities Version 1.0](#); accessed November 21, 2025). Ninety-fifth percentile-modeled results from HEM ranged from 0.0 to 91.2 $\mu\text{g}/\text{m}^3$ across all facilities for the 100, 100 to 1,000 and 1,000 m distances. This range is similar to the IIOAC 95th percentile results, which ranged from 0.0 to 109.5 $\mu\text{g}/\text{m}^3$ for the same distance rings. Table_Apx B-2 includes the HEM TRI 95th percentile-modeled concentrations for the 100, 100 to 1,000, and 1,000 m distances for each OES. Tables for the 95th- and 50th percentile-modeled concentrations across all distances based on TRI releases for these facilities are provided in Appendix B.1.4.4. Similar to the IIOAC results, the OESs and COUs associated with Plastic and rubber polymerization, Manufacturing, and Processing as a

reactant resulted in the highest modeled concentrations. For the full results of HEM-modeled concentrations based on TRI releases, including the 50th and 10th percentiles, see supplemental file *Human Exposure Model (HEM) TRI 2016–2021 Exposure and Risk Analysis for 1,3-Butadiene* ([U.S. EPA, 2025d](#)).

In addition, EPA conducted further refined modeling for the TRI facilities that had corresponding NEI 2017 and 2020 releases (*i.e.*, facilities that reported to both TRI and NEI databases). Details on HEM inputs for NEI releases are provided in Appendix B.1.5. Ninety-fifth percentile-modeled ambient air concentrations from HEM across these NEI facility releases and all distances (10–50,000 m) reporting in 2017 and 2020 ranged from 0.0 to 386.4 $\mu\text{g}/\text{m}^3$ —with the greatest concentrations modeled within the first 60 to 100 m from industrial facilities. This range is similar to the HEM 95th percentile results based on TRI releases. Table_Apx B-3 includes the HEM NEI 95th percentile-modeled concentrations for the 100, 100 to 1,000, and 1,000 m distances for each OES. Tables for the 95th- and 50th percentile-modeled concentrations across all distances based on NEI releases for these facilities are provided in Appendix B.1.5.4. See supplemental file: *Human Exposure Model (HEM) NEI 2017 and 2020 Exposure Analysis for 1,3-Butadiene* ([U.S. EPA, 2025d](#)) for more details.

Table_Apx B-2. HEM 95th Percentile Modeled Concentrations (µg/m³) Based on TRI 2016–2021 Releases

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)		
						(Based on 95th Percentile-Modeled Concentrations µg/m ³)		
						100	100–1,000	1,000
Manufacture	Import	Import	Manufacturing	40	Maximum	78	13	4.6
					Mean	12	1.9	0.59
					Median	3.3	0.57	0.16
					Minimum	0	0	0
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	33	Maximum	91	7.3	2.1
					Mean	11	1.2	0.32
					Median	3.4	0.48	0.13
					Minimum	8.3E–04	3.6E–04	1.4E–04
Processing	Processing – incorporation into article	Other: monomer in: rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	Maximum	5.3E–07	1.5E–07	4.3E–08
					Mean	5.3E–07	1.4E–07	4.3E–08
					Median	5.3E–07	1.4E–07	4.3E–08
					Minimum	5.3E–07	1.4E–07	4.3E–08
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: petrochemical manufacturing	Processing incorporation into formulation, mixture, or reaction product	53	Maximum	17	7	3.1
					Mean	1.0	0.21	7.9E–02
					Median	0.13	1.9E–02	5.6E–03
					Minimum	0	0	0
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	57	Maximum	30	3.0	0.77
					Mean	2.7	0.31	8.6E–02
					Median	0.41	6.4E–02	1.7E–02
					Minimum	0	0	0

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)		
						(Based on 95th Percentile-Modeled Concentrations µg/m³)		
						100	100–1,000	1,000
Disposal	Disposal	Disposal	Recycling	11	Maximum	0.71	8.5E–02	2.2E–02
					Mean	0.26	3.2E–02	9.2E–03
					Median	0.19	2.3E–02	6.1E–03
					Minimum	1.2E–03	3.0E–04	1.5E–04
Manufacturing	Import	Import	Repackaging	23	Maximum	20	2.4	0.51
		Mean			2.1	0.21	6.1E–02	
Processing	Repackaging	Intermediate in: wholesale and retail trade			Median	9.2E–02	1.4E–02	3.2E–03
		Minimum			1.4E–04	3.4E–05	1.4E–05	
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	7	Maximum	0.18	2.1E–02	6.9E–03
					Mean	3.9E–02	5.1E–03	1.6E–03
					Median	1.3E–03	3.5E–04	1.2E–04
					Minimum	2.8E–04	3.0E–05	8.3E–06
			Total	225				

Table_Apx B-3. HEM 95th Percentile-Modeled Concentrations ($\mu\text{g}/\text{m}^3$) Based on NEI 2017 and 2020 Releases

Life Cycle Stage	Category	Subcategory	OES	NEI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)		
						(Based on 95th Percentile-Modeled Concentrations $\mu\text{g}/\text{m}^3$)		
						100	100–1,000	1,000
Manufacture	Import	Import	Manufacturing	31	Max	390	21	3.7
					Mean	13	1.6	0.27
					Median	0.26	0.28	0.10
					Min	2.2E–06	6.4E–06	1.0E–06
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	39	Max	210	12	1.4
					Mean	8	1.0	0.16
					Median	0.42	0.21	5.3E–02
					Min	1.0E–11	8.8E–08	1.0E–07
Processing	Processing – incorporation into article	Other: Monomer in: Rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	Max	0.87	0.41	9.0E–02
					Mean	0.46	0.23	6.2E–02
					Median	0.46	0.23	6.2E–02
					Min	4.2E–02	5.3E–02	3.4E–02
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: Petrochemical manufacturing	Processing - incorporation into formulation, mixture, or reaction product	41	Max	3.9	0.35	7.8E–02
					Mean	0.16	2.9E–02	6.8E–03
					Median	1.2E–02	3.6E–03	1.1E–03
					Min	0	0	0

Life Cycle Stage	Category	Subcategory	OES	NEI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)		
						(Based on 95th Percentile-Modeled Concentrations µg/m³)		
						100	100–1,000	1,000
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	62	Max	16	4.1	6.5
					Mean	1.0	0.25	0.13
					Median	4.7E–02	1.4E–02	3.9E–03
					Min	0	0	0
Disposal	Disposal	Disposal	Recycling	7	Max	0.32	0.15	2.3E–02
					Mean	5.1E–02	1.5E–02	2.8E–03
					Median	2.4E–03	1.3E–03	2.9E–04
					Min	2.3E–11	3.0E–08	3.2E–08
Manufacturing	Import	Import	Repackaging	15	Max	47	5.2	0.81
					Mean	4.7	0.42	8.7E–02
Processing	Repackaging	Intermediate in: wholesale and retail trade			Median	0.12	6.1E–02	1.7E–02
					Min	6.3E–11	1.1E–06	9.7E–07

Life Cycle Stage	Category	Subcategory	OES	NEI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)		
						(Based on 95th Percentile-Modeled Concentrations $\mu\text{g}/\text{m}^3$)		
						100	100–1,000	1,000
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	6	Max	5.7E-02	3.9E-02	8.6E-03
					Mean	1.1E-02	5.7E-03	1.7E-03
					Median	1.2E-04	2.8E-04	8.0E-05
					Min	4.2E-11	3.3E-06	2.1E-06
			Total	201				

B.1.3 HEM Modeling Results by Census Blocks

As described in Appendix B.1, HEM provides results at the census block level for refined evaluation of cancer risk. HEM calculates an aggregated cancer risk value, the maximum individual risk (MIR), for each census block within 50 km of facility releases. This risk value is calculated by multiplying the aggregate census block ambient air concentration by the IUR. A general population IUR, which incorporates an ADAF of the IUR of 5.8×10^{-6} risk per $\mu\text{g}/\text{m}^3$ from the *Human Health Risk Assessment for 1,3-Butadiene* ([U.S. EPA, 2025e](#)), was applied for this assessment. HEM census block-based cancer risk estimates for census blocks based on TRI facility release data are provided in Table_Apx B-14. In response to public comment and recommendations from the Science Advisory Committee on Chemicals (SACC), EPA also includes HEM results at the census block level using NEI 2017 and 2020 release data as inputs for modeling ambient air concentrations and deriving risk estimates to the general population, see Section 5.3.4 of the *Risk Evaluation for 1,3-Butadiene* ([U.S. EPA, 2025h](#)).

HEM modeling output files based on 2016 to 2021 TRI highest facility releases are available as a supplemental file ([U.S. EPA, 2025j](#)).

B.1.4 HEM Model Inputs with TRI Data

B.1.4.1 Introduction

The Agency used release data from the EPA's [TRI](#) (accessed November 21, 2025), with [HEM v4.2](#) (accessed November 21, 2025) to estimate air concentrations resulting from air releases of 1,3-butadiene, modeled at census block receptors and co-located receptors surrounding the release sources. This appendix describes the setup of these model runs.

B.1.4.2 HEM

HEM v4.2 has two components: (1) an atmospheric dispersion model, AERMOD², with included meteorological data from AERMOD's AERMET module; and (2) U.S. Census Bureau population data at the block level. Both HEM versions utilize 2020 Census data—including all 50 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands.³ HEM estimates the magnitude and distribution of chemical concentrations in ambient air in the vicinity of each releasing facility within a user-defined radial distances out to 50 km (≈ 30 miles). HEM also provides chemical concentrations in ambient air at the centroid of over 8 million census blocks across the United States. The model is also able to combine the estimated chemical concentrations with dose-response data to estimate cancer risks and non-cancer hazards, and the population data to inform cancer incidence, and other risk measures. HEM utilizes local meteorological data for each release point, as well as local topographic information, to inform the dispersion model inputs. Refer to the [HEM 4.2 User Guide](#) (accessed November 21, 2025) for more details about these and other capabilities.

B.1.4.3 Model Settings

When downloading the HEM model for use, there are several reference library files required including: Toxicity Value Files Library, Census Files Library, and Meteorological Files Library. Contents within these reference libraries are presets based on available data (like EPA's IUR or Reference Concentrations [RfCs]) for many chemicals. Some of these reference library files can be modified by the user depending on needs. For example, for this 1,3-butadiene risk evaluation, EPA modified the IUR

² AERMOD website: [American Meteorological Society/Environmental Protection Agency Regulatory Model](#) (accessed November 21, 2025).

³ The HEM census file for the U.S. Virgin Islands has 0 people in each location. Block-level population data may not be currently available from the 2020 Census.

within the toxicity value files library for 1,3-butadiene to the IUR derived by OPPT and utilized in this risk evaluation based on EPA's systematic review process.

Prior to running HEM, the model requires the user to create a series of input files (minimum of 3 with several others optional) each of which is described in the HEM user guides. The three required input files are facility list options file, HAP emissions file, and emissions location file. Templates for each of these input files (and other optional input files) are included in the HEM download files. For this 1,3-butadiene assessment, EPA summarized values and settings used in the HEM "facility list" input file below (raw input files are included in the supplemental model files). Table_Apx B-4 indicates the values and settings used in the HEM "facility list" input file, whereas Table_Apx B-5, Table_Apx B-6, and Table_Apx B-7 provide additional information on those values and settings.

As shown in Table_Apx B-4, the input file directs HEM to match the nearest meteorological station to each facility by proximity (generally based on the latitude and longitude of each facility). Requiring this approach will reference the local meteorological data from the meteorological files reference library file described in the paragraph above. The meteorological dataset contains over 800 stations nationwide—most of which reflect 2019 meteorological conditions. The input file also directed HEM to determine if the facility was in an urban location using 2020 Census data. EPA explicitly modeled census block receptors within 3,000 m of each facility, with some exceptions noted in the tables, while the model interpolated results to other block receptors out to 50,000 m. All modeling scenarios utilized several rings of non-census receptors. The rings each had 16 had receptors placed every 22.5 degrees (starting due north of the facility) for distances ranging from 10 to 50,000 m from the facility. Then, there was one grid for 80 co-located receptors which was regularly spaced (at 10-meter intervals) between 30 and 60 m from the facility. Another grid was for 300 general population receptors and was regularly spaced (at 100-meter intervals) between 100 and 1,000 m from the facility.

EPA used TRI-reported release data from reporting years 2016 through 2021 to populate the HAP emissions file, which in turn are used as direct inputs to HEM. The release data are described and provided in the *Environmental Releases and Occupational Exposure Assessment for 1,3-Butadiene* ([U.S. EPA, 2025c](#)) and includes facility names, locations, identifier codes, OES assignments, annual air releases (stratified by fugitive and point sources), the inter-day air-release patterns, and identification of which TRI form the information was submitted under (Form R or Form A).

EPA modeled each year of TRI-reported releases separately. The Agency modeled TRI Form A and Form R records separately, such that there was one HEM run for all 2016 Form A facilities, one for all 2016 Form R facilities, and so on for 2017 to 2021. This ensured that any multi-facility aggregate outputs that HEM produced per run were confined to release data from the same year. EPA kept Form A data separate from Form R data because Form A releases are specified as either all stack releases or all fugitive releases but not both, and within each Form A run the Agency ran each facility's stack or fugitive source as a separate "facility" to prevent aggregation of the facility's stack and fugitive concentrations. Form A modeling utilized an "S" or "F" suffix to each facility ID to designate that it was the stack source or fugitive source being modeled.

Table_Apx B-4. Settings for HEM’s “Facility List” Input File

Parameter Group	Parameter	Value or Setting	Interpretation	Note
Dispersion Environment	met_station	[blank]	Model chose the meteorology station closest to each facility	
	rural_urban	[blank]	Model found the nearest census block to the facility center and determined whether that block was located in an urbanized area as designated by the 2020 Census	
	urban_pop	[blank]	Model used a default of 50,000 people for the urban population	
Modeling Domain Defined	max_dist	50,001	Model used a default of 50,000 m to define the modeling domain around each facility (entering 50,001 here forced a default of 50,000)	
	model_dist	50,001	Model used a default of 3,000 m to define the cutoff distance around each facility for explicitly modeling census block receptors, and then any block receptors beyond that had their modeling results interpolated from polar receptors (entering 50,001 here forced a default of 3,000)	For a small number of facilities, there were no populated block centroids within 3,000 m of the facility, and so this distance was set to 10,000 m, unless a larger value was needed to capture populated blocks (see Table_Apx B-5)
	radials	16	Model used polar receptors at the default of 16 radials	
	circles	11	Model used polar receptors at 11 concentric rings	
	overlap_dist	30	Model used a default 30 m to define the facility fence line, inside which receptors were not considered as a point of maximum exposure/risk	
	ring1	10	Model used 10 m for the distance of the first ring of polar receptors	
	fac_center	L, [custom for each facility: latitude, longitude]	Model used the facility latitude and longitude from TRI	
	ring_dists	10, 30, 60, 100, 1,000, 2,500, 5,000, 10,000, 15,000, 25,000, 50,000	Model used concentric rings of polar receptors at these distances (in meters)	

Parameter Group	Parameter	Value or Setting	Interpretation	Note
Acute Options	acute	N	Model did not estimate short-term concentrations	
	hours	[blank]		
	multiplier	[blank]		
	high_value	[blank]		
Deposition and Depletion Parameters	dep	[blank]	Model did not estimate deposition	
	depl	[blank]		
	pdep	[blank]		
	pdepl	[blank]		
	vdep	[blank]		
	vdepl	[blank]		
Additional Options	elev	Y	Model included the elevation of receptors in the concentration estimates	
	user_rcpt	N	Model did not use additional user-specified receptors (beyond the polar grid and census blocks), which is the default choice	
	bldg_dw	N	Model did not estimate building downwash, which is the default choice	
	fastall	Y	Model used AERMOD's FASTALL option to conserve model run time by simplifying the dispersion algorithms, which is not the default choice	
	emiss_var	Y	Model used time-varying emissions, specified in a separate file	Separate file used AERMOD's MHRDOW7 format allowing emission rates to vary by month, hour of day, and the seven days of the week (see Table_Apx B-6 and Table_Apx B-7)
	annual	Y	Model used the default setting to calculate an annual average as a long-term concentration, which is the default choice	
	period_start	[blank]		
	period_end	[blank]		

Table_Apx B-5. Substitutions Made for the Facility List File’s “model dist” Parameter

TRI Facility ID	Modeled Distance (m)
00851HSSLVLIMET	10,000
77503MCCHM1500N	10,000
77503MCCHM1500N_F ^a	10,000
77503MCCHM1500N_S ^a	10,000
77536DSPSL2525B	10,000
77536SFTYK2027B	10,000
77571QNTMC1515M	10,000
77643WSTMNHWY73	10,000
79086DMNDSSTARR	10,000
84029SFTYK11600	44,000
89003SCLGYHWY95	45,000
^a This was a TRI Form A submission for this facility, where the stack emissions and fugitive emissions were modeled as separate “facilities” to prevent aggregation of the stack and fugitive results at the facility.	

Table_Apx B-6. Assumptions for Intraday Emission-Release Duration

Hours per Day of Emissions	Assumed Hours of the Day Emitting
Unknown	All hours

Table_Apx B-7. Assumptions for Inter-Day Emission-Release Pattern

Days per Year of Emissions	Release Pattern
250	Monday to Friday, except no Fridays in January to March Equals 247–249 days/year, depending on the year Emission factor when emissions on = 1.473
300	Monday to Saturday, except no Saturdays in January to March. Equals 200–201 days/year, depending on the year Emission factor when emissions on = 1.217
350	All days, except no Sundays in January to April. Equals 347–349 days/year, depending on the year Emission factor when emissions on = 1.05

Table_Apx B-8 summarizes the physical source specifications used in the HEM “emission location” input file for point (stack) and area (fugitive) sources; these are the same default physical parameters as

in EPA's IIOAC, which enables more direct comparisons between the two model outputs. In some cases, for a given year and TRI form, EPA provided multiple sets of stack releases or multiple sets of fugitive releases at a given facility; in these cases, the Agency aggregated the releases to one overall stack release and one overall fugitive release at the facility.

Table_Apx B-8. Physical Source Specifications

Source Type	Parameter (Unit)	Value
Point (stack)	Stack height (m)	10
	Inside stack diameter (m)	2
	Exit gas velocity (m/sec)	5
	Exit gas temperature (Kelvin)	300
Area (fugitive)	Release height (m)	3.05
	Length (m)	10
	Width (m)	10
	Angle (°)	0

Although modeling was completed, risk calculations were not completed at one releasing facility, due to its U.S. Virgin Islands location and the population values being 0 in HEM's census files (see Table_Apx B-9). This facility was only in the 2020 Form R modeling.

Table_Apx B-9. Facilities Not Modeled for Risks

TRI Facility ID	Notes
00851HSSLVLIMET	The AERMOD run completed and concentration results were reported out. However, the risk calculations did not complete (HEM recorded it as a "skipped facility"), apparently due to there being no population values above 0 in vicinity. This is a U.S. Virgin Islands location. Although HEM's Census Library contains information on the Islands, all the population values are 0. HEM's risk estimates at census locations may not operate correctly if all locations have 0 people.

When each HEM run completed, EPA ran the model's risk summary reports to produce outputs which provide additional information that informs the ambient air pathway exposure assessment. EPA's runs included population analysis at the census block level to show aggregate exposures on the same receptor from multiple facilities in proximity to each census block. The Agency also ran the demographics assessment within HEM for all census blocks which summarizes various socioeconomic factors within each census block and across the country. EPA temporarily removed the U.S. Virgin Islands facility with zero population results from the 2020 Form R output folder when running these summary reports to exclude it from the summary reports and allow completion of the demographics assessment.

The results from the HEM modeling of TRI data are summarized in Table_Apx B-10 and Table_Apx B-11 for the 95th- and 50th percentile-modeled concentration, respectively, from the entire distribution of HEM-modeled concentrations for facilities within each OES and COU (life cycle, category and subcategory) across all distances modeled (finite and area distances).

B.1.4.4 HEM TRI Results

Table_Apx B-10. HEM TRI 2016–2021 95th Percentile-Modeled Concentrations Across All Distances by OESs and COUs

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities	Stat	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 95th Percentile Modeled Concentrations µg/m³)												
						10	30	30-60	60	100	100–1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Manufacture	Import	Import	Manufacturing	40	Max	120	200	160	110	78	13	4.6	1.4	0.54	0.20	0.11	5.5E-02	1.9E-02
					Mean	22	39	30	21	12	1.9	0.60	0.16	5.9E-02	2.1E-02	1.2E-02	5.5E-03	2.0E-03
					Median	4.1	8.6	6.7	5.0	3.3	0.57	0.16	5.7E-02	2.2E-02	8.2E-03	4.6E-03	2.2E-03	7.5E-04
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	33	Max	290	380	270	190	91	7.3	2.1	0.49	0.17	5.5E-02	2.9E-02	1.3E-02	4.3E-03
					Mean	33	45	33	23	11	1.2	0.32	7.7E-02	2.6E-02	9.2E-03	5.0E-03	2.3E-03	8.2E-04
					Median	4.3	11	9.0	6.3	3.4	0.49	0.13	3.1E-02	1.0E-02	3.6E-03	1.9E-03	8.5E-04	3.1E-04
					Min	2.8E-09	4.2E-06	1.8E-04	3.3E-04	8.3E-04	3.6E-04	1.4E-04	3.9E-05	1.4E-05	5.1E-06	2.8E-06	1.3E-06	4.7E-07
Processing	Processing – incorporation into article	Other: Monomer in: Rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	Max	2.9E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
					Mean	3.0E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
					Median	3.0E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
					Min	3.0E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: Petrochemical manufacturing	Processing - incorporation into formulation, mixture, or reaction product	53	Max	15	39	33	24	17	6.6	3.1	0.86	0.33	0.12	6.5E-02	3.0E-02	1.1E-02
					Mean	1.5	2.9	2.3	1.6	1.0	0.21	8.0E-02	2.2E-02	8.2E-03	3.0E-03	1.6E-03	7.3E-04	2.7E-04
					Median	8.6E-02	0.21	0.19	0.16	0.13	1.9E-02	5.6E-03	1.7E-03	5.7E-04	2.2E-04	1.2E-04	4.8E-05	1.7E-05
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities	Stat	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 95th Percentile Modeled Concentrations µg/m³)												
						10	30	30-60	60	100	100–1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	57	Max	83	120	110	71	30	3.0	0.77	0.18	6.2E-02	2.1E-02	1.1E-02	5.0E-03	1.8E-03
					Mean	6.2	10	8.1	5.6	2.8	0.31	8.7E-02	2.2E-02	7.8E-03	2.8E-03	1.5E-03	7.0E-04	2.5E-04
					Median	0.8	1.5	1.1	0.74	0.41	6.4E-02	1.7E-02	4.2E-03	1.3E-03	4.2E-04	2.2E-04	9.9E-05	3.6E-05
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Disposal	Disposal	Disposal	Recycling	11	Max	1.4	2.3	2.0	1.4	0.71	8.5E-02	2.2E-02	5.3E-03	2.1E-03	7.1E-04	3.6E-04	1.5E-04	5.5E-05
					Mean	0.36	0.76	0.63	0.48	0.26	3.2E-02	9.2E-03	2.2E-03	7.5E-04	2.5E-04	1.4E-04	5.8E-05	2.1E-05
					Median	0.13	0.42	0.35	0.26	0.19	2.3E-02	6.1E-03	1.5E-03	4.7E-04	1.6E-04	1.3E-04	5.2E-05	1.8E-05
					Min	4.4E-09	1.1E-04	5.0E-04	7.1E-04	1.2E-03	3.0E-04	1.5E-04	5.2E-05	1.8E-05	5.9E-06	3.0E-06	1.3E-06	5.3E-07
Manufacturing	Import	Import	Repackaging	23	Max	62	93	66	42	20	2.4	0.51	0.12	4.1E-02	1.4E-02	7.6E-03	3.4E-03	1.2E-03
					Mean	4.8	8.8	6.2	4.2	2.1	0.21	6.1E-02	1.5E-02	5.0E-03	1.7E-03	9.3E-04	4.2E-04	1.5E-04
Processing	Repackaging	Intermediate in: wholesale and retail trade			Median	0.19	0.56	0.39	0.21	9.2E-02	1.4E-02	3.2E-03	8.3E-04	3.1E-04	1.0E-04	5.7E-05	2.8E-05	1.0E-05
					Min	9.0E-10	8.1E-07	2.3E-04	2.2E-04	1.4E-04	3.4E-05	1.4E-05	5.6E-06	1.9E-06	6.2E-07	3.2E-07	1.6E-07	5.7E-08
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	7	Max	0.49	0.73	0.60	0.38	0.18	2.1E-02	6.9E-03	2.0E-03	7.5E-04	2.6E-04	1.4E-04	6.6E-05	2.4E-05
					Mean	7.5E-02	0.12	0.10	6.6E-02	4.0E-02	5.1E-03	1.6E-03	4.1E-04	1.5E-04	5.1E-05	2.7E-05	1.3E-05	4.4E-06
					Median	6.8E-03	5.8E-03	4.5E-03	2.6E-03	1.3E-03	3.5E-04	1.2E-04	3.1E-05	1.1E-05	3.7E-06	1.9E-06	8.8E-07	3.1E-07
					Min	2.6E-08	2.1E-05	3.8E-04	4.8E-04	2.9E-04	3.1E-05	8.3E-06	2.9E-06	1.2E-06	5.2E-07	3.3E-07	1.7E-07	6.0E-08
			Total	225														

Table_Apx B-11. 1,3-Butadiene Cancer Risks Based on HEM 95th Percentile-Modeled Concentrations from 10–50,000 Meters

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities		Estimated Cancer Risk Using Maximum Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 95th Percentile Modeled Concentrations)												
				Total	Risk Above 1E-06 at 100 m	10	30	30-60	60	100	100-1,000	1,000	2,500	5,000	1,0000	15,000	25,000	50,000
Manufacture	Domestic manufacturing	Domestic manufacturing	Manufacturing	40	31	7.0E-04	1.2E-03	9.4E-04	6.6E-04	4.6E-04	7.8E-05	2.7E-05	8.0E-06	3.1E-06	1.2E-06	6.6E-07	3.2E-07	1.1E-07
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	33	30	1.7E-03	2.2E-03	1.6E-03	1.1E-03	5.3E-04	4.3E-05	1.2E-05	2.9E-06	9.6E-07	3.2E-07	1.7E-07	7.5E-08	2.5E-08
Processing	Processing – incorporation into article	Other: monomer in: rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	0	1.7E-17	1.8E-12	2.2E-12	2.4E-12	3.1E-12	8.5E-13	2.5E-13	1.1E-13	4.9E-14	2.1E-14	1.2E-14	5.8E-15	2.1E-15
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: petrochemical manufacturing	Processing – incorporation into formulation, mixture, or reaction product	53	25	8.9E-05	2.3E-04	1.9E-04	1.4E-04	9.9E-05	3.8E-05	1.8E-05	5.0E-06	1.9E-06	6.9E-07	3.8E-07	1.8E-07	6.4E-08
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	57	38	4.8E-04	7.2E-04	6.4E-04	4.1E-04	1.8E-04	1.7E-05	4.5E-06	1.1E-06	3.6E-07	1.2E-07	6.6E-08	2.9E-08	1.1E-08

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities		Estimated Cancer Risk Using Maximum Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 95th Percentile Modeled Concentrations)												
				Total	Risk Above 1E-06 at 100 m	10	30	30-60	60	100	100-1,000	1,000	2,500	5,000	1,0000	15,000	25,000	50,000
Disposal	Disposal	Disposal	Recycling	11	6	7.9E-06	1.3E-05	1.1E-05	8.4E-06	4.1E-06	4.9E-07	1.3E-07	3.1E-08	1.2E-08	4.1E-09	2.1E-09	8.7E-10	3.2E-10
Manufacturing	Import	Import	Repackaging															
Processing	Repackaging	Intermediate in: wholesale and retail trade		23	10	3.6E-04	5.4E-04	3.9E-04	2.5E-04	1.2E-04	1.4E-05	3.0E-06	7.0E-07	2.4E-07	8.3E-08	4.4E-08	2.0E-08	6.9E-09
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	7	1	2.9E-06	4.3E-06	3.5E-06	2.2E-06	1.0E-06	1.2E-07	4.0E-08	1.2E-08	4.4E-09	1.5E-09	8.4E-10	3.9E-10	1.4E-10
Total				225	141													

Table_Apx B-12. HEM TRI 2016–2021 50th Percentile-Modeled Concentrations Across All Distances by OESs and COUs

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities	Stat	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 50th Percentile Modeled Concentrations µg/m³)												
						10	30	30-60	60	100	100–1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Manufacture	Import	Import	Manufacturing	40	Max	120	200	160	110	78	13	4.6	1.4	0.54	0.20	0.11	5.5E-02	1.9E-02
					Mean	22	39	30	21	12	1.9	0.60	0.16	5.9E-02	2.1E-02	1.2E-02	5.5E-03	2.0E-03
					Median	4.1	8.6	6.7	5.0	3.3	0.57	0.16	5.7E-02	2.2E-02	8.2E-03	4.6E-03	2.2E-03	7.5E-04
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	33	Max	290	380	270	190	91	7.3	2.1	0.49	0.17	5.5E-02	2.9E-02	1.3E-02	4.3E-03
					Mean	33	45	33	23	11	1.2	0.32	7.7E-02	2.6E-02	9.2E-03	5.0E-03	2.3E-03	8.2E-04
					Median	4.3	11	9.0	6.3	3.4	0.49	0.13	3.1E-02	1.0E-02	3.6E-03	1.9E-03	8.5E-04	3.1E-04
					Min	2.8E-09	4.2E-06	1.8E-04	3.3E-04	8.3E-04	3.6E-04	1.4E-04	3.9E-05	1.4E-05	5.1E-06	2.8E-06	1.3E-06	4.7E-07
Processing	Processing – incorporation into article	Other: monomer in: rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	Max	2.9E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
					Mean	3.0E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
					Median	3.0E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
					Min	3.0E-12	3.0E-07	3.7E-07	4.1E-07	5.3E-07	1.5E-07	4.3E-08	1.9E-08	8.4E-09	3.6E-09	2.0E-09	1.0E-09	3.6E-10
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: petrochemical manufacturing	Processing - incorporation into formulation, mixture, or reaction product	53	Max	15	39	33	24	17	6.6	3.1	0.86	0.33	0.12	6.5E-02	3.0E-02	1.1E-02
					Mean	1.5	2.9	2.3	1.6	1.0	0.21	8.0E-02	2.2E-02	8.2E-03	3.0E-03	1.6E-03	7.3E-04	2.7E-04
					Median	8.6E-02	0.21	0.19	0.16	0.13	1.9E-02	5.6E-03	1.7E-03	5.7E-04	2.2E-04	1.2E-04	4.8E-05	1.7E-05
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities	Stat	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 50th Percentile Modeled Concentrations µg/m³)												
						10	30	30-60	60	100	100–1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	57	Max	83	120	110	71	30	3.0	0.77	0.18	6.2E-02	2.1E-02	1.1E-02	5.0E-03	1.8E-03
					Mean	6.2	10	8.1	5.6	2.8	0.31	8.7E-02	2.2E-02	7.8E-03	2.8E-03	1.5E-03	7.0E-04	2.5E-04
					Median	0.79	1.5	1.1	0.74	0.41	6.4E-02	1.7E-02	4.2E-03	1.3E-03	4.2E-04	2.2E-04	9.9E-05	3.6E-05
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Disposal	Disposal	Disposal	Recycling	11	Max	1.4	2.3	2.0	1.4	0.71	8.5E-02	2.2E-02	5.3E-03	2.1E-03	7.1E-04	3.6E-04	1.5E-04	5.5E-05
					Mean	0.36	0.76	0.63	0.48	0.26	3.2E-02	9.2E-03	2.2E-03	7.5E-04	2.5E-04	1.4E-04	5.8E-05	2.1E-05
					Median	0.13	0.42	0.35	0.26	0.19	2.3E-02	6.1E-03	1.5E-03	4.7E-04	1.6E-04	1.3E-04	5.2E-05	1.8E-05
					Min	4.4E-09	1.1E-04	5.0E-04	7.1E-04	1.2E-03	3.0E-04	1.5E-04	5.2E-05	1.8E-05	5.9E-06	3.0E-06	1.3E-06	5.3E-07
Manufacturing	Import	Import	Repackaging	23	Max	62	93	66	42	20	2.4	0.51	0.12	4.1E-02	1.4E-02	7.6E-03	3.4E-03	1.2E-03
					Mean	4.8	8.8	6.2	4.2	2.1	0.21	6.1E-02	1.5E-02	5.0E-03	1.7E-03	9.3E-04	4.2E-04	1.5E-04
Processing	Repackaging	Intermediate in: Wholesale and retail trade			Median	0.19	0.56	0.39	0.21	9.2E-02	1.4E-02	3.2E-03	8.3E-04	3.1E-04	1.0E-04	5.7E-05	2.8E-05	1.0E-05
					Min	9.0E-10	8.1E-07	2.3E-04	2.2E-04	1.4E-04	3.4E-05	1.4E-05	5.6E-06	1.9E-06	6.2E-07	3.2E-07	1.6E-07	5.7E-08
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	7	Max	0.49	0.73	0.60	0.38	0.18	2.1E-02	6.9E-03	2.0E-03	7.5E-04	2.6E-04	1.4E-04	6.6E-05	2.4E-05
					Mean	7.5E-02	0.12	0.10	6.6E-02	4.0E-02	5.1E-03	1.6E-03	4.1E-04	1.5E-04	5.1E-05	2.7E-05	1.3E-05	4.4E-06
					Median	6.8E-03	5.8E-03	4.5E-03	2.6E-03	1.3E-03	3.5E-04	1.2E-04	3.1E-05	1.1E-05	3.7E-06	1.9E-06	8.8E-07	3.1E-07
					Min	2.6E-08	2.1E-05	3.8E-04	4.8E-04	2.9E-04	3.1E-05	8.3E-06	2.9E-06	1.2E-06	5.2E-07	3.3E-07	1.7E-07	6.0E-08
Total			225															

Table_Apx B-13. 1,3-Butadiene Cancer Risks Based on HEM 50th Percentile-Modeled Concentrations from 10–50,000 Meters

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities		Estimated Cancer Risk Using Maximum Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 50th Percentile Modeled Concentrations)												
				Total	Risk Above 1E-06 at 100 m	10	30	30-60	60	100	100-1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Manufacturing	Domestic manufacturing	Domestic manufacturing	Manufacturing	40	27	2.7E-04	6.7E-04	4.5E-04	3.4E-04	1.8E-04	1.7E-05	9.8E-06	3.1E-06	1.2E-06	4.6E-07	2.5E-07	1.3E-07	4.6E-08
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	33	29	3.5E-04	6.2E-04	4.4E-04	3.1E-04	1.5E-04	8.7E-06	4.7E-06	1.2E-06	4.2E-07	1.5E-07	8.2E-08	3.7E-08	1.3E-08
Processing	Processing – incorporation into article	Other: monomer in: rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	0	8.8E-18	2.0E-14	3.7E-13	5.8E-13	1.2E-12	3.1E-13	2.1E-13	6.6E-14	2.5E-14	1.0E-14	5.1E-15	2.0E-15	7.6E-16
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: petrochemical manufacturing	Processing – incorporation into formulation, mixture, or reaction product	53	11	4.1E-05	8.1E-05	5.7E-05	4.3E-05	2.2E-05	2.1E-06	1.7E-06	7.1E-07	3.1E-07	1.2E-07	6.5E-08	3.0E-08	1.1E-08
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber	Processing as a reactant	57	25	1.2E-04	3.3E-04	2.0E-04	1.3E-04	5.9E-05	2.8E-06	1.5E-06	4.4E-07	1.7E-07	6.4E-08	3.5E-08	1.6E-08	5.8E-09

Life Cycle Stage	Category	Subcategory	OES	TRI Facilities		Estimated Cancer Risk Using Maximum Concentration Across Facilities Within OES by Distance from All Sources (m)													
						(Based on 50th Percentile Modeled Concentrations)													
				Total	Risk Above 1E-06 at 100 m	10	30	30-60	60	100	100-1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000	
		manufacturing; wholesale and retail trade																	
Disposal	Disposal	Disposal	Recycling	11	2	2.2E-06	7.6E-06	6.2E-06	4.5E-06	1.9E-06	8.3E-08	4.4E-08	1.0E-08	3.4E-09	1.1E-09	6.1E-10	2.7E-10	9.7E-11	
Manufacturing	Import	Import	Repackaging	23	6														
Processing	Repackaging	Intermediate in: wholesale and retail trade		8.6E-05	2.0E-04	1.4E-04	1.0E-04	4.9E-05	2.5E-06	1.3E-06	3.2E-07	1.1E-07	3.8E-08	2.0E-08	9.2E-09	3.4E-09			
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	7	0	7.9E-08	2.3E-07	1.5E-07	1.1E-07	1.0E-07	2.6E-08	1.4E-08	4.6E-09	1.9E-09	7.1E-10	3.9E-10	1.8E-10	6.3E-11	
			Total	225	100														

Table_Apx B-14. Inhalation Census Block Cancer Risk Estimates Based on HEM TRI 2016–2021 Highest Releases

Life Cycle Stage	Category	Subcategory	OES	Facility Count (N)	Range of Maximum Facility Cancer Risks		Facility Count with ≥ 1 in 1,000,000 Risk (1E-06)	Facility Count with ≥ 1 in 100,000 Risk (1E-05)	Facility Count with ≥ 1 in 10,000 Risk (1E-04)
					Min	Max			
Manufacturing	Domestic manufacturing	Domestic manufacturing	Manufacturing	40	1.7E-10	3.1E-05	21	4	0
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	33	8.4E-10	4.3E-05	19	6	0
Processing	Processing – incorporation into article	Other: monomer in: rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	1.1E-12	1.1E-12	0	0	0
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: petrochemical manufacturing	Processing – incorporation into formulation, mixture, or reaction product	53	4.7E-12	9.8E-05	3	1	1
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	56	3.3E-10	1.4E-05	12	2	0
Disposal	Disposal	Disposal	Recycling	11	6.7E-10	1.1E-06	1	0	0

Life Cycle Stage	Category	Subcategory	OES	Facility Count (N)	Range of Maximum Facility Cancer Risks		Facility Count with ≥ 1 in 1,000,000 Risk (1E-06)	Facility Count with ≥ 1 in 100,000 Risk (1E-05)	Facility Count with ≥ 1 in 10,000 Risk (1E-04)
					Min	Max			
Manufacture	Import	Import	Repackaging	23	7.1E-11	8.4E-06	4	0	0
Processing	Repackaging	Intermediate in: wholesale and retail trade							
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	7	1.8E-12	2.5E-07	0	0	0
Total				224					

B.1.5 HEM Model Inputs with NEI Data

B.1.5.1 Introduction

The Agency used release data from the EPA’s NEI with HEM, to estimate air concentrations resulting from air releases of 1,3-butadiene, modeled at census block receptors and co-located receptors surrounding the release sources. Because the setup of these model runs is generally the same as described in Appendix B.1 for the TRI dataset, EPA focuses the following sections on those areas where the setup using the NEI dataset differed.

B.1.5.2 HEM

HEM v4.2 has two components: (1) an atmospheric dispersion model, AERMOD⁴, with included meteorological data; and (2) U.S. Census Bureau population data at the block level. The current HEM version utilizes 2020 Census data—including all 50 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands.⁵ AERMOD estimates the magnitude and distribution of chemicals concentrations in ambient air in the vicinity of each releasing facility within a user-defined radial distances out to 50 km (about 30 miles). HEM also provides chemical concentrations in ambient air at the centroid of over 8 million census blocks across the United States. The model also is able to combine the estimated chemical concentrations with dose-response data to estimate cancer risks and non-cancer hazards, and the population data to inform cancer incidence, and other risk measures. HEM automatically utilizes meteorological data for each release point, as well as local topographic information, to inform the release dispersion model. Refer to the [HEM 4.2 User Guide](#) (accessed November 21, 2025) for more details about these and other capabilities.

B.1.5.3 Model Settings

Most of the HEM model settings for using the NEI dataset are identical to those described in the previous section for TRI. However, the NEI dataset has some additional information or unique information and therefore this section describes only those unique aspects associated with the NEI dataset.

EPA used NEI-reported release data from reporting years 2017 and 2020 to populate the HAP emissions file which in turn are used as direct inputs to the HEM model. The release data are described and provided in the *Environmental Releases and Occupational Exposure Assessment for 1,3-Butadiene* ([U.S. EPA, 2025c](#)) and includes, among others, facility names, locations, identifier codes, OES assignments, and annual air releases (stratified by fugitive and point sources).

EPA modeled each year of NEI-reported releases separately. This ensured that any multi-facility aggregate outputs that HEM produced per run were confined to release data from the same year. Table_Apx B-15 summarizes the values and settings used in the HEM “facility list” input file, and Table_Apx B-16 through Table_Apx B-20 provide additional information on those values and settings.

⁴ Page for AERMOD ([American Meteorological Society/Environmental Protection Agency Regulatory Model](#); accessed November 21, 2025).

⁵ The HEM census file for the U.S. Virgin Islands has 0 people in each location. Block-level population data may not be currently available from the 2020 Census.

Table_Apx B-15. Settings for HEM’s “Facility List” Input File

Parameter Group	Parameter	Value or Setting	Interpretation	Note
Dispersion Environment	met_station	[blank]	Model chose the meteorology station closest to each facility	
	rural_urban	[blank]	Model found the nearest census block to the facility center and determined whether that block was located in an urbanized area as designated by the 2020 U.S. Census	
	urban_pop	[blank]	Model used a default of 50,000 people for the urban population	
Modeling Domain Defined	max_dist	50001	Model used a default of 50,000 m to define the modeling domain around each facility (entering 50,001 here forced a default of 50,000 m)	
	model_dist	51001	Model used a default of 3,000 m to define the cutoff distance around each facility for explicitly modeling census block receptors, and then any block receptors beyond that had their modeling results interpolated from polar receptors (entering 51,001 here forced a default of 3,000)	For a small number of facilities, there were no populated block centroids within 3,000 m of the facility, and so we set this distance to a value slightly larger than the value needed to include a populated block centroid (see Table_Apx B-2)
	radials	16	Model used polar receptors at the default of 16 radials	
	circles	11	Model used polar receptors at 11 concentric rings	
	overlap_dist	30	Model used a default 30 m to define the facility fence line, inside which receptors were not considered as a point of maximum exposure/risk	
	ring1	10	Model used 10 m for the distance of the first ring of polar receptors	

Parameter Group	Parameter	Value or Setting	Interpretation	Note
Modeling Domain Defined (continued)	fac_center	L, [custom for each facility: latitude, longitude]	Model used a facility latitude and longitude which we calculated as the average of all the facility's source coordinates being modeled	
	ring_dists	10, 30, 60, 100, 1000, 2500, 5000, 10000, 15000, 25000, 50000	Model used concentric rings of polar receptors at these distances (in meters)	
Acute Options	acute	Y	Model calculated short-term concentrations	
	hours	24	Model defined "short term" as 24 hours (i.e., daily)	
	multiplier	1	Model used the hourly emissions as-is, without multiplying them by a factor that would approximate short-term emission rates above baseline	
	high_value	18	Model reports the 18th-highest acute concentration at each receptor (this approximates the 95th-percentile daily concentration)	
Deposition and Depletion Parameters	dep	[blank]	Model did not estimate deposition	
	depl	[blank]		
	pdep	[blank]		
	pdepl	[blank]		
	vdep	[blank]		
	vdepl	[blank]		
Additional Options	elev	[blank]	Model included the elevation of receptors in the concentration estimates	

Parameter Group	Parameter	Value or Setting	Interpretation	Note
Additional Options (continued)	user_rcpt	Y	Model used additional user-specified receptors (beyond the polar grid and census blocks)— <i>i.e.</i> , the grids at 30–60 m and 100–1,000 m from the facility	
	bldg_dw	N	Model did not estimate building downwash, which is the default choice	
	fastall	Y	Model used AERMOD's FASTALL option to conserve model run time by simplifying the dispersion algorithms, which is not the default choice	
	emiss_var	Y	Model used time-varying emissions, specified in a separate file	Separate file used AERMOD's MHRDOW7 format allowing emission rates to vary by month, hour of day, and the 7 days of the week (see Table_Apx B-6 and Table_Apx B-7)
	annual	Y	Model used the default setting to calculate an annual average as a long-term concentration, which is the default choice	
	period_start	[blank]		
	period_end	[blank]		

Table_Apx B-16. Substitutions Made for the Facility List File’s “model_dist” Parameter

FacilityID	model_dist (m)	
	2017	2020
1019211	NA	4,358
1134111	7,108	7,108
1163311	5,463	5,463
4030511	5,574	5,608
4784711	4,276	4,277
4841311	4,318	NA
5632411	4,718	4,699
5633211	5,265	5,265
5763011	4,079	4,079
6145011	16,599	16,599
6284911	4,248	4,248
6422011	4,236	4,088
6444911	4,698	4,698
6478611	7,458	7,458
6981411	4,685	4,685
7301611	15,803	NA
7428011	20,991	20,932
13381011	4,125	4,125
14553711	6,294	NA
14559411	7,762	NA
16911211	NA	4,303
16932711	NA	4,128
18973511	NA	4,438
19077411	NA	4,275
“NA” indicates the facility was not in that year’s release inventory. Some values were slightly different between inventory years due to slight differences in facility coordinates.		

Table_Apx B-17. Assumptions for Intraday Emission-Release Duration

Hours per Day of Emissions from EPA	Assumed Hours of the Day Emitting for Modeling
0.1, 1	1: Hour 13 (hour ending at 1 pm; <i>i.e.</i> , 12–1 pm)
2	2: Hours 13–14 (hour ending at 1 pm through hour ending at 2 pm; <i>i.e.</i> , 12 to 2 pm)
4	4: Hours 13–16 (hour ending at 1 pm through hour ending at 4 pm; <i>i.e.</i> , 12 to 4 pm)
5	5: Hours 13–17 (hour ending at 1 pm through hour ending at 5 pm; <i>i.e.</i> , 12 to 5 pm)
5.7	6: Hours 12–17 (hour ending at 12 pm through hour ending at 5 pm; <i>i.e.</i> , 11 am to 5 pm)
8	8: Hours 9–16 (hour ending at 9 am through hour ending at 4 pm; <i>i.e.</i> , 8 am to 4 pm)
9	9: Hours 9–17 (hour ending at 9 am through hour ending at 5 pm; <i>i.e.</i> , 8 am to 5 pm)
10	10: Hours 9–18 (hour ending at 9 am through hour ending at 6 pm; <i>i.e.</i> , 8 am to 6 pm)
11.2	11: Hours 9–19 (hour ending at 9 am through hour ending at 7 pm; <i>i.e.</i> , 8 am to 7 pm)
15	15: Hours 6–20 (hour ending at 6 am through hour ending at 8 pm; <i>i.e.</i> , 5 am to 8 pm)
16, 16.5	16: Hours 6–21 (hour ending at 6 am through hour ending at 9 pm; <i>i.e.</i> , 5 am to 9 pm)
18	18: Hours 5–22 (hour ending at 5 am through hour ending at 10 pm; <i>i.e.</i> , 4 am to 10 pm)
20, 20.4	20: Hours 4–23 (hour ending at 4 am through hour ending at 11 pm; <i>i.e.</i> , 3 am to 11 pm)
24	All hours

Table_Apx B-18. Assumptions for Inter-Day Emission-Release Pattern

Days per Year of Emissions from EPA	Assumed Days of the Year Emitting for Modeling		
	Which Days	Number of Days per Year ^a	Emission Factor when Emissions On ^b
1	Mondays in January	4 or 5	82.3–1,974.0
8.5, 10	Mondays in January and June	9	40.6–974.7
20, 23.5, 24, 26	Mondays in January–February, April, July, and October	20 or 23	17.1–410.0
36	Mondays in January–March, May–June, August–September, and November–December	38 or 40	9.4–225.1
52	All Mondays	52	7.1–168.7
72.3	All Mondays, and Tuesdays in January–April	69	5.3–127.1
86.7	All Mondays, and Tuesdays in January–May, and Wednesdays in January–April	91	4.0–96.4
120	All Mondays–Tuesdays, and Wednesdays in January–April	121 or 122	3.0–72.2
146, 153.8	All Mondays–Tuesdays, and Wednesdays in January–November	152	2.4–57.7
172, 182	All Mondays–Wednesdays, and Thursdays in January–June	182 or 183	2.0–48.1

Days per Year of Emissions from EPA	Assumed Days of the Year Emitting for Modeling		
	Which Days	Number of Days per Year ^a	Emission Factor when Emissions On ^b
200, 208	All Mondays–Wednesdays, and Thursdays in January–October	199 or 201	1.8–43.9
250, 255	All Mondays–Thursdays, and Fridays in January–September	247 or 249	1.5–35.4
260, 260.7, 262	All Mondays–Fridays	260 or 262	1.4–33.6
269.7	All Mondays–Fridays, and Saturdays in January–February	268 or 271	1.4–32.6
282, 283	All Mondays–Fridays, and Saturdays in January–April	277 or 279	1.3–31.6
286, 293	All Mondays–Fridays, and Saturdays in January–July	290 or 292	1.3–30.2
300, 300.2, 301.9, 302, 305	All Mondays–Fridays, and Saturdays in January–September	299 or 301	1.2–29.2
309.1, 312, 315	All Mondays–Fridays, and Saturdays in January–November	307 or 310	1.2–28.4
318.5, 320, 322, 324.4	All Mondays–Saturdays, and Sundays in January–February	321 or 322	1.1–27.3
328.1, 329, 335	All Mondays–Saturdays, and Sundays in January–April	330 or 331	1.1–26.5
336, 342, 343, 344.9, 345	All Mondays–Saturdays, and Sundays in January–June	338 or 340	1.1–25.9
349, 350, 350.6, 355.1	All Mondays–Saturdays, and Sundays in January–August	347 or 349	1.1–25.2
356, 357, 360	All Mondays–Saturdays, and Sundays in January–November	360 or 362	1.0–24.3
364, 364.7, 364.9, 365, 365.6, 366, 530.9, 570, 1,095 ^c	All days	365 or 366	1.0–24.0
^a Depending on the year. ^b Depending on the number of hours per day. ^c It is unclear why values above 366 days/year were included in the release inventory.			

Unlike TRI, the NEI dataset sometimes includes site-specific (process unit-specific) physical release parameters (*e.g.*, stack height, exit velocity, stack diameter, fugitive area source height). Therefore, for the HEM modeling runs using the NEI dataset, when such site-specific information was reported to NEI, EPA used the reported values for the inputs to HEM.

When parameter values were not available or were outside of normal bounds, those values were replaced based on the procedures that EPA uses in its AirToxScreen (see Section 2.1.3 of the AirToxScreen

technical support document⁶). Table_Apx B-19 provides the replacement procedures as followed. In some cases, there were several steps or passes for making decisions on replacing values. For some stack parameters, the first pass for replacing values involved identifying default values based on the Source Classification Code (SCC) of the emission source, and where needed (*i.e.*, where there were no defaults for the source's SCC) the second pass procedure implemented global default values). If all passes described in Table_Apx B-19 fail, EPA used the same default physical parameters as used in EPA's IIOAC and for the HEM TRI runs.

Table_Apx B-19. Physical Source Specifications

Parameter	Bounds	Condition			
		Value Is Missing or 0			Value is Out of Normal Bounds
		First Pass	Second Pass (First Pass Unsuccessful)	Third Pass (First Two Passes Unsuccessful)	
Stack height	1–1300 ft (0.3048–396 m)	Use default value by SCC (pstk file)	Use global default: 3 m	N/A	Use the minimum or maximum in-bound value if below or above bounds, respectively
Stack inside diameter	0.001–300 ft (0.0003048–91.4 m)	Use default value by SCC (pstk file)	Use global default: 0.2 m	N/A	Use the minimum or maximum in-bound value if below or above bounds, respectively
Stack exit gas temperature ^a	>0–4000 F (>255.4–2477.6 K)	Use default value by SCC (pstk file)	Use global default: 295.4 K	N/A	Use the minimum or maximum in-bound value if below or above bounds, respectively
Stack exit gas velocity	0.001–1000 ft/s (0.0003048–304.8 m/s)	Calculate from existing exit gas flow rate and inside diameter: $(4 \cdot \text{flow}) / (\pi \cdot \text{diameter}^2)$	Use default value by SCC (pstk file)	Use global default: 4 m/s	Use the minimum or maximum in-bound value if below or above bounds, respectively
Fugitive height	N/A	3.048 m if length <u>or</u> width are missing <u>or</u> 0. (Leave at 0 m	N/A	N/A	N/A

⁶ EPA 2018 AirToxScreen Technical Support Document: https://www.epa.gov/system/files/documents/2023-02/AirToxScreen_2018%20TSD.pdf. (accessed November 21, 2025)

Parameter	Bounds	Condition			
		Value Is Missing or 0			Value is Out of Normal Bounds
		First Pass	Second Pass (First Pass Unsuccessful)	Third Pass (First Two Passes Unsuccessful)	
		if length <u>and</u> width are not missing <u>and</u> are above 0.)			
Fugitive length	N/A	10 m	N/A	N/A	N/A
Fugitive width	N/A	10 m	N/A	N/A	N/A
Fugitive angle	N/A	0 deg	N/A	N/A	N/A
Ft = feet; m = meters; F = degrees Fahrenheit; K = Kelvin; s = second; SCC = Source Classification Code; deg = degrees ^a For exit gas temperatures, we modified AirToxScreen's value bounds so that values must be above 0 F. Notes: pstk file = file of default stack parameters by source classification code (SCC) from EPA's SMOKE emissions kernel: pstk_13nov2018_v1.txt, retrieved on 28 September 2022 from https://cmascenr.org/smoke/ (accessed November 21, 2025).					

Table_Apx B-20 details the numbers of modeled sources and the numbers of sources that had replaced values of physical source specifications following the rules in Table_Apx B-19.

Table_Apx B-20. Details on Where Replacements Were Made for Physical Source Specifications

Release Year	Source Type	Number of Sources	Release Height	Stack Inside Diameter	Stack Exit Gas Velocity	Stack Exit Gas Temperature	Fugitive Length	Fugitive Width	Fugitive Angle
2017	Point	Vertical: 2,170 Horizontal: 309 Goose Neck: 128 Vertical with Rain Cap: 215 Downward Facing Vent: 222 TOTAL: 3,044	No issues	No issues	Problem: 645 sources with values of 0 or missing. Solution: Replaced with value calculated from exit gas flow rate and inside stack diameter. 4 of those replacements were above bounds and capped at 304.8 m/s.	No issues	NA	NA	NA
	Fugitive	1,902	Problem: 1,764 sources with values of 0 or missing, while also having values of 0 or missing for fugitive length or fugitive width. Solution: Replaced with 3.048 m.	NA	NA	NA	Problem: 1,902 sources with values of 0 or missing. Solution: Replaced with 10 m.	Problem: 1,899 sources with values of 0 or missing. Solution: Replaced with 10 m.	No issues

Release Year	Source Type	Number of Sources	Release Height	Stack Inside Diameter	Stack Exit Gas Velocity	Stack Exit Gas Temperature	Fugitive Length	Fugitive Width	Fugitive Angle
2020	Point	Vertical: 2,272 Horizontal: 109 Goose Neck: 45 Vertical with Rain Cap: 37 Downward Facing Vent: 23 TOTAL: 2,486	Problem: 129 sources had values above bounds. Solution: Replaced with 396 m.	Problem: 1 source with a missing value. Solution: Replaced with default value based on SCC.	Problem: 785 sources with values of 0 or missing. Solution: Replaced with value calculated from exit gas flow rate and inside stack diameter. 6 of those replacements were above bounds and capped at 304.8 m/s.	No issues	NA	NA	NA
	Fugitive	2,035	Problem: 1,769 sources with values of 0 or missing, while also having values of 0 or missing for fugitive length or fugitive width. Solution: Replaced with 3.048 m.	NA	NA	NA	Problem: 2,035 sources with values of 0 or missing. Solution: Replaced with 10 m.	Problem: 2,032 sources with values of 0 or missing. Solution: Replaced with 10 m.	No issues

As with the HEM TRI runs, although modeling was completed, risk calculations were not completed at one releasing facility, located in the U.S. Virgin Islands, due to its population values being 0 in HEM's census files (see Table_Apx B-21). This facility was only included in the 2020 modeling.

Table_Apx B-21. Facilities Not Modeled for Risks

FacilityID	Notes
7439411 (in the 2020 inventory)	The AERMOD run completed and concentration results were reported out. However, the risk calculations did not complete (HEM recorded it as a "skipped facility"), apparently due to there being no population values above 0 in vicinity. This is a U.S. Virgin Islands location. While HEM's Census Library contains information on the Islands, all the population values are 0. HEM's risk estimates at census locations may not operate correctly if all locations have 0 people.

When a HEM NEI run completed, EPA also ran HEM's risk summary reports to produce outputs that account for impacts on the same receptor from multiple neighboring facilities. The Agency also ran the demographics assessment which summarizes modeled impacts by various socioeconomic factors. EPA assumes that the skipped facility was not included in these aggregations; thus, these temporarily removed the skipped facility from the 2020 output folder to ensure successful completion of the demographics assessment. For a small number of facilities, one of the non-census receptors was roughly co-located with a census receptor, so HEM deduplicated it and left it as only a census receptor so that its results were not double counted.

EPA assumes that the skipped facility was not included in these aggregations; thus, these were temporarily removed from the 2020 output folder to ensure successful completion of the demographics assessment. For a small number of facilities, one of the non-census receptors was roughly co-located with a census receptor, so HEM deduplicated it and left it as only a census receptor so that its results were not double counted.

The results from the HEM modeling of NEI data are summarized in Table_Apx B-22 and Table_Apx B-23 for the 95th- and the 50th percentile-modeled concentration, respectively, from the entire distribution of HEM-modeled concentrations for each facility within each OESs and COUs (life cycle, category and subcategory) across all distances modeled (finite and area distances).

B.1.5.4 HEM NEI Results

Table_Apx B-22. HEM NEI 2017 and 2020 95th Percentile-Modeled Concentrations Across All Distances by OESs and COUs

Life Cycle Stage	Category	Subcategory	OES	NEI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 95th Percentile Modeled Concentrations $\mu\text{g}/\text{m}^3$)												
						10	30	30-60	60	100	100–1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Manufacture	Import	Import	Manufacturing	31	Max	27	27	32	110	390	21	3.7	0.58	0.19	6.5E-02	3.7E-02	1.9E-02	8.5E-03
					Mean	2.4	3.0	3.4	4.9	13	1.6	0.27	5.5E-02	2.0E-02	7.1E-03	4.0E-03	1.9E-03	7.3E-04
					Median	0.26	0.28	0.28	0.30	0.26	0.28	0.10	2.2E-02	7.9E-03	2.8E-03	1.5E-03	7.1E-04	2.6E-04
					Min	1.9E-09	2.2E-08	3.9E-07	5.3E-07	2.2E-06	6.4E-06	1.0E-06	2.2E-07	7.0E-08	2.2E-08	1.2E-08	5.4E-09	1.9E-09
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	39	Max	120	180	140	210	210	12	1.4	0.27	0.11	4.4E-02	2.6E-02	1.3E-02	5.0E-03
					Mean	5.3	7.6	7.2	8.2	7.5	1.0	0.16	3.5E-02	1.3E-02	4.8E-03	2.7E-03	1.3E-03	5.2E-04
					Median	0.28	0.31	0.40	0.35	0.42	0.21	5.3E-02	1.1E-02	3.6E-03	1.4E-03	7.6E-04	3.3E-04	1.3E-04
					Min	0	0	6.8E-18	4.6E-15	1.0E-11	8.8E-08	1.0E-07	1.2E-07	5.2E-08	2.2E-08	1.5E-08	9.7E-09	5.7E-09
Processing	Processing – incorporation into article	Other: monomer in: rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	Max	0.58	0.65	0.66	0.71	0.87	0.41	9.0E-02	2.1E-02	7.7E-03	2.9E-03	1.6E-03	7.8E-04	2.9E-04
					Mean	0.31	0.34	0.35	0.37	0.46	0.23	6.2E-02	1.6E-02	6.0E-03	2.2E-03	1.3E-03	6.0E-04	2.3E-04
					Median	0.31	0.34	0.35	0.37	0.46	0.23	6.2E-02	1.6E-02	6.0E-03	2.2E-03	1.3E-03	6.0E-04	2.3E-04
					Min	3.5E-02	3.5E-02	3.7E-02	3.7E-02	4.2E-02	5.3E-02	3.4E-02	1.1E-02	4.3E-03	1.6E-03	8.9E-04	4.3E-04	1.7E-04
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: petrochemical manufacturing	Processing - incorporation into formulation, mixture, or reaction product	41	Max	11	14	13	8.2	3.9	0.35	7.8E-02	3.0E-02	7.3E-03	1.9E-03	8.6E-04	4.2E-04	1.5E-04
					Mean	0.36	0.55	0.47	0.28	0.16	2.9E-02	6.8E-03	1.7E-03	5.4E-04	1.7E-04	9.4E-05	4.2E-05	1.6E-05
					Median	5.9E-03	6.0E-03	9.3E-03	8.4E-03	1.2E-02	3.6E-03	1.1E-03	2.8E-04	1.0E-04	3.4E-05	2.1E-05	7.7E-06	2.8E-06
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0

Life Cycle Stage	Category	Subcategory	OES	NEI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 95th Percentile Modeled Concentrations µg/m³)												
						10	30	30-60	60	100	100–1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	62	Max	30	30	21	14	16	4.1	6.5	0.42	0.15	5.2E-02	3.0E-02	1.5E-02	6.0E-03
					Mean	1.4	1.5	1.3	1.0	1.0	0.25	0.13	1.7E-02	5.9E-03	2.1E-03	1.2E-03	5.7E-04	2.2E-04
					Median	3.2E-02	4.9E-02	4.5E-02	4.7E-02	4.7E-02	1.4E-02	3.9E-03	1.2E-03	4.4E-04	1.5E-04	8.3E-05	3.9E-05	1.6E-05
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Disposal	Disposal	Disposal	Recycling	7	Max	0.22	0.40	0.36	0.22	0.32	0.15	2.3E-02	4.1E-03	1.2E-03	3.9E-04	2.0E-04	9.5E-05	4.1E-05
					Mean	4.0E-02	7.5E-02	0.11	6.0E-02	5.1E-02	1.5E-02	2.8E-03	5.6E-04	1.9E-04	6.9E-05	4.0E-05	1.9E-05	8.1E-06
					Median	1.8E-03	1.9E-03	2.7E-03	2.1E-03	2.4E-03	1.3E-03	2.9E-04	7.2E-05	4.2E-05	2.5E-05	1.6E-05	7.9E-06	2.9E-06
					Min	0	2.0E-24	1.2E-14	9.0E-14	2.3E-11	3.0E-08	3.2E-08	1.3E-08	6.0E-09	3.3E-09	2.5E-09	1.7E-09	9.5E-10
Manu-facturing	Import	Import	Repackaging	15	Max	60	64	48	120	47	5.2	0.81	0.16	5.0E-02	1.6E-02	8.8E-03	4.0E-03	1.4E-03
					Mean	3.7	4.5	3.9	8.1	4.7	0.42	8.7E-02	1.8E-02	5.8E-03	1.9E-03	1.0E-03	4.7E-04	1.6E-04
Processing	Repackaging	Intermediate in: wholesale and retail trade			Median	0.20	0.22	0.20	0.19	0.12	6.1E-02	1.7E-02	6.7E-03	2.2E-03	7.3E-04	3.8E-04	1.7E-04	6.0E-05
					Min	0	0	3.3E-16	2.9E-15	6.3E-11	1.1E-06	9.7E-07	3.1E-07	2.2E-07	1.5E-07	1.1E-07	6.6E-08	3.1E-08
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	6	Max	3.7E-02	4.1E-02	4.5E-02	4.7E-02	5.7E-02	3.9E-02	8.6E-03	1.8E-03	6.9E-04	2.8E-04	1.6E-04	8.1E-05	3.3E-05
					Mean	5.7E-03	6.4E-03	7.5E-03	8.0E-03	1.1E-02	5.7E-03	1.7E-03	4.6E-04	1.9E-04	7.6E-05	4.5E-05	2.3E-05	9.9E-06
					Median	1.3E-07	1.5E-05	1.1E-04	8.9E-05	1.2E-04	2.8E-04	8.0E-05	2.5E-05	1.0E-05	3.8E-06	2.2E-06	1.2E-06	5.7E-07
					Min	0	0	5.7E-22	4.5E-17	4.2E-11	3.3E-06	2.1E-06	7.1E-07	2.6E-07	9.9E-08	5.8E-08	3.0E-08	1.2E-08
			Total	201														

Table_Apx B-23. HEM NEI 2017 and 2020 50th Percentile-Modeled Concentrations Across All Distances by OESs and COUs

Life Cycle Stage	Category	Subcategory	OES	NEI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 50th Percentile Modeled Concentrations µg/m³)												
						10	30	30-60	60	100	100-1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Manufacture	Import	Import	Manufacturing	31	Max	27	27	27	27	26	1.4	0.82	0.24	8.5E-02	3.2E-02	1.8E-02	9.2E-03	4.0E-03
					Mean	2.1	2.1	2.0	2.0	1.8	0.20	0.11	2.8E-02	1.0E-02	3.7E-03	2.1E-03	1.0E-03	3.8E-04
					Median	0.26	0.26	0.25	0.23	0.19	8.1E-02	4.7E-02	1.2E-02	4.4E-03	1.6E-03	8.6E-04	4.1E-04	1.5E-04
					Min	1.4E-11	1.2E-08	9.5E-08	2.0E-07	8.6E-07	1.0E-06	5.1E-07	1.1E-07	3.7E-08	1.2E-08	6.2E-09	2.7E-09	9.6E-10
Processing	Processing as a reactant	Other: monomer used in polymerization process in: plastic material and resin manufacturing; manufacturing synthetic rubber and plastics	Plastics and rubber polymerization	39	Max	77	39	27	34	25	1.3	0.66	0.17	7.0E-02	2.9E-02	1.7E-02	8.4E-03	3.3E-03
					Mean	3.4	2.9	2.2	2.0	1.3	0.14	7.4E-02	2.0E-02	7.4E-03	2.8E-03	1.6E-03	7.8E-04	3.0E-04
					Median	0.26	0.27	0.28	0.29	0.24	4.0E-02	2.3E-02	6.5E-03	2.3E-03	7.6E-04	3.4E-04	1.7E-04	6.4E-05
					Min	0	0	7.5E-28	3.4E-21	6.0E-14	3.9E-08	5.8E-08	5.3E-08	2.6E-08	1.2E-08	8.2E-09	5.3E-09	2.9E-09
Processing	Processing – incorporation into article	Other: monomer in: rubber and plastic product manufacturing	Plastics and rubber compounding and converting	1	Max	0.54	0.55	0.50	0.56	0.54	8.0E-02	3.7E-02	1.0E-02	3.8E-03	1.5E-03	8.2E-04	4.0E-04	1.5E-04
					Mean	0.29	0.29	0.27	0.30	0.29	4.8E-02	2.5E-02	7.6E-03	3.0E-03	1.1E-03	6.5E-04	3.1E-04	1.2E-04
					Median	0.29	0.29	0.27	0.30	0.29	4.8E-02	2.5E-02	7.6E-03	3.0E-03	1.1E-03	6.5E-04	3.1E-04	1.2E-04
					Min	3.5E-02	3.4E-02	3.4E-02	3.3E-02	3.2E-02	1.6E-02	1.2E-02	5.2E-03	2.2E-03	8.4E-04	4.7E-04	2.3E-04	8.5E-05
Processing	Processing – incorporation into formulation, mixture, or reaction product	Processing aids, not otherwise listed in: petrochemical manufacturing	Processing - incorporation into formulation, mixture, or reaction product	41	Max	7.9	7.2	4.8	2.9	1.3	4.9E-02	2.3E-02	5.1E-03	1.6E-03	5.3E-04	2.9E-04	1.3E-04	4.7E-05
					Mean	0.22	0.26	0.18	0.12	5.8E-02	4.6E-03	2.5E-03	6.5E-04	2.2E-04	7.6E-05	4.2E-05	1.8E-05	7.0E-06
					Median	3.0E-03	3.2E-03	5.8E-03	5.9E-03	5.8E-03	7.1E-04	4.2E-04	1.0E-04	3.1E-05	1.4E-05	8.2E-06	3.4E-06	1.2E-06
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0

Life Cycle Stage	Category	Subcategory	OES	NEI Facilities	Statistic	Ambient Concentration Across Facilities Within OES by Distance from All Sources (m)												
						(Based on 50th Percentile Modeled Concentrations µg/m³)												
						10	30	30-60	60	100	100–1,000	1,000	2,500	5,000	10,000	15,000	25,000	50,000
Processing	Processing as a reactant	Intermediate in: adhesive manufacturing; all other basic organic chemical manufacturing; fuel binder for solid rocket fuels; organic fiber manufacturing; petrochemical manufacturing; petroleum refineries; plastic material and resin manufacturing; propellant manufacturing; synthetic rubber manufacturing; wholesale and retail trade	Processing as a reactant	62	Max	14	0.17	11	7.3	5.8	1.1	0.84	0.15	5.8E-02	2.5E-02	1.5E-02	7.6E-03	3.0E-03
					Mean	0.71	0.81	0.55	0.44	0.27	4.6E-02	2.8E-02	6.8E-03	2.5E-03	9.5E-04	5.3E-04	2.6E-04	1.0E-04
					Median	2.4E-02	2.9E-02	2.3E-02	2.6E-02	1.9E-02	2.9E-03	1.8E-03	4.4E-04	1.6E-04	5.6E-05	3.2E-05	1.6E-05	6.0E-06
					Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Disposal	Disposal	Disposal	Recycling	7	Max	0.13	0.18	0.20	0.11	0.11	2.3E-02	1.2E-02	3.1E-03	8.9E-04	2.8E-04	1.5E-04	6.0E-05	2.1E-05
					Mean	2.5E-02	4.2E-02	5.0E-02	2.7E-02	1.8E-02	2.5E-03	1.2E-03	3.1E-04	9.6E-05	3.4E-05	1.9E-05	8.5E-06	3.4E-06
					Median	4.3E-04	1.7E-03	2.3E-03	1.7E-03	1.7E-03	2.5E-04	1.4E-04	3.2E-05	1.4E-05	8.4E-06	6.0E-06	3.8E-06	1.4E-06
					Min	0	3.1E-29	3.9E-18	5.4E-15	1.0E-11	1.2E-08	1.4E-08	6.5E-09	2.9E-09	1.7E-09	1.3E-09	9.1E-10	4.9E-10
Manufacturing	Import	Import	Repackaging	15	Max	4.4	5.6	2.5	2.4	2.2	0.90	0.41	6.9E-02	2.4E-02	8.5E-03	4.5E-03	2.0E-03	7.2E-04
					Mean	0.83	0.84	0.55	0.58	0.42	7.0E-02	3.7E-02	7.8E-03	2.7E-03	9.4E-04	5.0E-04	2.3E-04	8.2E-05
Processing	Repackaging	Intermediate in: wholesale and retail trade			Median	0.17	8.1E-02	9.5E-02	8.0E-02	6.8E-02	1.6E-02	9.8E-03	2.4E-03	8.1E-04	2.7E-04	1.4E-04	6.3E-05	2.1E-05
					Min	0	0	5.6E-22	4.8E-16	2.4E-11	7.2E-07	6.3E-07	2.0E-07	1.2E-07	7.8E-08	5.8E-08	3.6E-08	1.7E-08
Disposal	Disposal	Disposal	Waste handling, disposal, treatment, and recycling	6	Max	3.5E-02	3.4E-02	3.3E-02	3.2E-02	2.8E-02	6.6E-03	3.9E-03	9.8E-04	4.0E-04	1.7E-04	1.1E-04	5.4E-05	2.1E-05
					Mean	5.4E-03	5.5E-03	5.5E-03	5.6E-03	5.0E-03	1.2E-03	7.6E-04	2.5E-04	1.1E-04	4.7E-05	2.8E-05	1.5E-05	6.4E-06
					Median	7.3E-09	6.2E-06	2.6E-05	2.2E-05	3.3E-05	7.1E-05	4.0E-05	1.3E-05	5.2E-06	2.0E-06	1.2E-06	6.7E-07	3.1E-07
					Min	0	0	0	1.5E-27	6.4E-15	1.1E-06	9.0E-07	3.7E-07	1.5E-07	5.5E-08	3.1E-08	1.6E-08	6.2E-09
			Total	201														